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GUIDE TO PROGRAMS

FISCAL YEAR

1991

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National Science Foundation

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Program Changes

Any changes in NSF's fiscal year 1991 programs occurring after presstime for this Guide will be announced promptly by the Foundation. The NSF Bulletin, available from NSF at no charge, regularly publishes this and other information, including program schedules and deadlines (with updates when needed), and notices about brochures describing the various programs. To receive a copy, write to:

Editor, NSF Bulletin
National Science Foundation / Public Affairs
Washington, D.C. 20550

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1991 Catalog of Federal Domestic Assistance

National Science Foundation programs described in this publication fall under the following categories in the latest Catalog of Federal Domestic Assistance issued by the Office of Management and Budget and the General Services Administration:

47.009 - Graduate Research Fellowships
47.041 - Engineering Grants
47.049 - Mathematical and Physical Sciences
47.050 - Geosciences
47.051 - Biological, Behavioral, and Social Sciences
47.053 - Scientific, Technological, and International Affairs
47.066 - Teacher Preparation and Enhancement
47.067 - Materials Development, and Informal Science Education
47.068 - Research Studies and Program Assessment
47.069 - Research Initiation and Improvement
47.070 - Computer and Information Science and Engineering
47.071 - Undergraduate Science, Engineering, and Mathematics Education
47.072 - Young Scholars
47.073 - Science and Technology Centers
47.074 - Research Facilities Office

National Science Foundation

Guide to Programs

Fiscal Year 1991

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Director's Statement

Frederick M. Bernthal
Acting Director
National Science Foundation

The National Science Foundation enters its fifth decade with a record to be proud of — and serious challenges for the next 40 years.

Four decades have seen our budget grow from $3.5 million in the early 1950's to over $2.1 billion in fiscal year 1990. In 1952 the Foundation made 28 awards; in 1990, some 17,000. Today, NSF supports basic research not only in the traditional disciplines (mathematics, physical sciences, biological and behavioral sciences, geosciences), but in areas that might have seemed more like science fiction when NSF was created in 1950: biotechnology, high-temperature superconductors, robotics, supercomputers, quarks, lasers, and stratospheric ozone "holes."

Over the years, engineering and education have taken their rightful place as major NSF concerns. And international cooperation in research is no longer an occasional adventure; it is a daily necessity with the arrival of the global economy as we contemplate our place in the 21st century.

The United States is facing a serious shortage in our future supply of scientists and engineers, even as we face a critical deficiency in educating our people in the language of the global economy — science and mathematics. Women, minorities, and disabled persons make up a large, almost untapped, source of potential scientific and technical talent. To help meet our needs in the 21st century, NSF must point the way to including these groups in the future of science and engineering.

To our traditional partner in the nation's research enterprise — academia — we have added new partners, among them industry and state governments. Their presence is evident in such NSF activities as the annual National Science & Technology Week; Alliances for Minority Participation, a new program to expand the human resource base for science and engineering; joint research endeavors through Engineering Research Centers, Science and Technology Centers, and Industry-University Cooperative Research Centers; and the Statewide Systemic Initiative in education.

At NSF there must be unwavering support for the many gifted individuals who form the nation's talent pool of researchers. Last year, with Foundation backing, they pushed back the frontiers of:

- *Biological Diversity Research*: Responding to growing ecology concerns here, at home, and around the globe;
- *Earth System History:* Studies to help us understand how, when, and why our globe is changing;
- *Computer Science — Recognizing the critical role of computers in the information age*: Efforts to increase the speed and capacity of data storage systems and to expand large nationwide networks;
- *Materials Science and Engineering:* Focusing on a variety of materials — from semiconductors and superconductors to high-strength polymers and complex composites — that can be used in industry and other settings.

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These exemplify the NSF programs and activities described in this *Guide.*

The challenges ahead turn in part on the recent pivotal changes in the international order, and on major fiscal and social concerns here at home. As political conflict among the great powers recedes, the barriers to scientific interaction and cooperation fall. More than ever, world competition is played out in an economic arena. In the new global economy, knowledge is truly power — and basic research produces the kind of knowledge we will need to compete and to lead in the 21st century.

In the next 40 years, researchers will no doubt explore new frontiers of learning, again creating new disciplines and fields and new bodies of knowledge. NSF will continue to support the very best research — and the pioneers who pursue it. That is our continuing challenge, and we welcome it.

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Introduction

The National Science Foundation (NSF) is an independent agency of the Federal Government established in 1950 to promote and advance scientific progress in the United States. The Foundation does this primarily by sponsoring scientific and engineering research and education. NSF does not itself conduct research.

The Foundation makes awards for research and education in the sciences and engineering. The awardee is wholly responsible for the conduct of such work and preparation of the results for publication. The Foundation, therefore, does not assume responsibility for such findings or their interpretation.

The Foundation considers proposals for support of research and education in any field of science, including but not necessarily limited to astronomy, atmospheric sciences, biological and behavioral sciences, chemistry, computer sciences, earth sciences, engineering, information science, materials research, mathematical sciences, oceanography, physics, and social sciences. Interdisciplinary proposals also are eligible for consideration.

NSF normally will not support clinical research, including research on the etiology, diagnosis, or treatment of physical or mental disease, abnormality, or malfunction in human beings. Using animals or animal models of such conditions and developing or testing drugs or other procedures to treat them also generally are not eligible.

NSF does not normally support technical assistance, pilot plant efforts, research requiring security classification, the development of products for commercial marketing, or market research for a particular product or invention. The National Science Board is the policymaking body of the National Science Foundation. Its 25 members, including the Director of the Foundation, are appointed by the President of the United States, with the consent of the U.S. Senate. The Board approves new Foundation programs and grants or contracts requiring a total commitment of more than $6 million or an annual expenditure of more than $1.5 million, or as otherwise specified by the Board.

Proposals are assigned to the most appropriate NSF division or office for review. Before they submit proposals, all applicants should contact program officers for current information and other help. An organization chart showing major program areas is at the end of this Guide. In deciding which proposals to support, the Foundation relies heavily on the advice and help of advisory committees, outside reviewers, and other experts to ensure that NSF reaches fair and knowledgeable judgments. These scientists, engineers, and educators come from colleges and universities, nonprofit research and educational organizations, industry, and other Government agencies.

Most proposals come to NSF from educational institutions and other organizations rather than from individuals. However, individuals may submit proposals under special circumstances; check this Guide and the appropriate program brochures, or contact the program of interest for details.

The Foundation welcomes proposals on behalf of all qualified scientists and engineers and strongly encourages women, members of minority groups, and persons with disabilities to compete fully in all of its programs.

The Foundation also accepts proposals for basic and applied research from commercial firms, and it especially welcomes those from small businesses that have strong capabilities in scientific or engineering research. However, NSF does not wish to substitute Federal support for normal commercial investment in research or to compromise the role of educational institutions, where research makes a special contribution to science and engineering education. (For information of interest to small businesses see chapter 8.)

The Foundation encourages collaboration between industry and university researchers, and between industry and State and local governments. Similarly, broader efforts through industry associations, groups of companies, or professional societies may be supported. Contact the appropriate program for information and guidance before preparing such a proposal.

Awards may be made in response to both solicited and unsolicited proposals. Normally, those that are not solicited require cost-sharing or joint funding between NSF and the awardee(s).

Awards for solicited proposals may provide for payment of all costs. Proposals in response to specific program announcements so indicate.

Experimental, developmental, or research projects supported by NSF under awards to profit and nonprofit organizations will contain provisions consistent with Sections 202-204 of Title 35 of the United States Code (commonly called the Bayh-Dole Act), the Presidential Memorandum of 2-18-83 "Government Patent Policy," and the Foundation's patent regulation published as 45 of Federal Regulations, Part 650—unless the Foundation determines that some other provision would better serve the purposes of the Act or the interests of the United States and the general public.

The National Science Foundation looks forward to using and integrating the resources of all institutions in the support of science and engineering research and education and their contributions to society and the Nation.

Criteria for the Selection of Research and Education Projects

To provide for the fair and equitable selection of the most meritorious research and education projects for support, the National Science Foundation has established criteria for their review and evaluation. These criteria are meant to be applied to all proposals in a balanced and judicious manner, according to the objectives and content of each proposal. Four criteria for the selection of projects by the National Science Foundation are listed below, together with the elements that constitute each criterion.

1. Competent performance of the research—This criterion relates to the capability of the investigator(s), the technical soundness of the proposed approach, and the adequacy of the institutional resources available.
2. Intrinsic merit of the research—This criterion is used to assess the likelihood that the research will lead to new discoveries or fundamental advances within its field of science or engineering or have substantial impact on progress in that field or in other scientific and engineering fields.
3. Utility or relevance of the research—This criterion is used to assess the likelihood that the research can contribute to the achievement of a goal that is extrinsic or in addition to that of the research field itself and thereby serve as the basis for new or improved technology or assist in the solution of societal problems.
4. Effect of the research on the infrastructure of science and engineering—This criterion relates to the potential of the proposed research to contribute to better understanding or improvement of the quality, distribution, or effectiveness of the Nation's scientific and engineering research, education, and manpower base.

Criteria (1), (2), and (3) constitute an integral set that is applied in a balanced way to all proposals according to the objectives and content of each proposal. Criterion (1), competent performance, is essential to the evaluation of the quality of every proposal. The relative weight given criteria (2) and (3) depends on the nature of the proposed research. Criterion (2), intrinsic merit, is emphasized in evaluating basic research proposals, while Criterion (3), utility or relevance, is stressed in evaluating applied research proposals. Criterion (3) also relates to major goal-oriented activities that the Foundation carries out, such as those directed at improving the knowledge base underlying science and technology policy, furthering international cooperation in science and engineering, and addressing areas of national need.

Criterion (4), effect on the infrastructure of science and engineering, permits the evaluation of proposals in terms of their potential for improving the scientific and engineering enterprise and its educational activities in ways other than those encompassed by the first three criteria. Included under this criterion are questions relating to scientific and engineering personnel, including participation of women and minorities; the distribution of resources with respect to institutions and geographical area; stimulation of quality activities in important but underdeveloped fields; and the use of interdisciplinary approaches to research in appropriate areas. Any specific criteria that apply to individual programs, while falling within general criteria presented in this section, are contained in relevant program announcements or solicitations.

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BIOLOGICAL, BEHAVIORAL, AND SOCIAL SCIENCES

Individual research projects supported by these programs are designed to strengthen scientific understanding of biological and social phenomena. Research is supported across the spectrum, from the fundamental molecules of living organisms to the complex interactions of human beings and societal organizations.

Although most of the projects supported are on the "basic" end of the research spectrum, the programs accept and fund proposals for applied work as well. Support may also be provided for research workshops, symposia, publications and monographs, conferences, the purchase of scientific equipment for research purposes, the operation of specialized research facilities, and the improvement of research collections. Selected programs provide support for postdoctoral research fellowships.

To provide reasonable assurance of long-term support for continuing projects of high scientific merit, funding may be provided for periods up to 60 months, in annual increments, contingent upon the availability of funds and satisfactory progress of the research.

Institutions are required to share in the cost of unsolicited research projects supported by NSF grants or contracts.

Before submitting a proposal for research support, consult the brochure *Grants for Research and Education in Science and Engineering* (NSF 90-77) for guidance in preparing the application. A recommended format and some standard forms are in the brochure.

For information on Doctoral Dissertation Research Improvement awards, see Chapter 8.

Arabidopsis Thaliana *(Drawing courtesy of Dr. Chris Somerville, Michigan State University).*

Eligibility

The most frequent recipients of support for basic scientific research in the biological, behavioral, and social sciences are academic institutions and nonprofit research groups. In special circumstances, grants also are awarded to other types of institutions and to individuals. In these cases, preliminary inquiry should be made to the appropriate program officer before a proposal is submitted. Support may be provided for projects involving a single scientist or a number of scientists. Awards are made for projects confined to a single disciplinary area and for those that cross or merge disciplinary interests.

Deadlines

Proposals may be submitted at any time. For review within six months, proposals should be submitted in line with target dates, which vary by division and by program. Target dates are published regularly in the NSF *Bulletin*.

For More Information

Contact the responsible division director, National Science Foundation, Washington, D.C. 20550.

Areas of Research

The major research areas of NSF programs in the Biological, Behavioral, and Social Sciences (BBS) are summarized below. Note: Support is not provided for clinical research, biomedical research, or research with disease-related goals. Examples of areas of research that will not be considered are: epidemiology; toxicology; the development or testing of drugs or procedures for their use; diagnosis or treatment of disease, abnormality, or malfunction in human beings or animals; and animal models of such conditions. Investigators with questions regarding appropriateness of their research are encouraged to contact the most appropriate program prior to submitting a proposal.

In addition to the research areas described below, BBS has launched a directorate-wide initiative, the *Minority Postdoctoral Research Fellowship Program.* This special program of postdoctoral research fellowships will help prepare exceptionally trained minority scientists to assume positions of scientific leadership in academia. The fellowships will be awarded to underrepresented minority scientists for scientific research in disciplines covered by BBS. In addition, travel awards will be available to help potential fellows identify, meet, and select prospective mentors.

Cellular Biosciences

- **Cell Biology—**Supports studies on the biology of plant, animal, and prokaryotic cells. This includes: structure, function, and assembly of the cytoskeleton, membranes, organelles and intracellular compartments, extracellular matrix, and other structural elements; meiosis and mitosis; regulation of cell shape, polarity and motility; mechanisms of endocytosis, secretion, and other cellular activities; cellular mechanisms of self-recognition and self-defense; and transmembrane signaling phenomena, including ion channels in cells other than neurons and excitation-response coupling.

- **Cellular Biochemistry—**Supports research on mechanisms of regulation and characterization of biochemical pathways and cellular processes by which plants, microbes, and animals assimilate and transform metabolites and provide energy for vital functions. Emphasis is on integrating knowledge of the pathways and regulation of metabolism at the gene, enzyme, membrane, and organelle level.

- **Developmental Biology—**Supports research on the nature and control of those processes which define the life cycles of plants, animals, and microorganisms. The scope of the program includes study of fertilization, pattern formation, morphogenesis, gametogenesis and senescence. Experimental approaches range from molecular analysis of gene expression to analysis at the whole organism level.

- **Physiological Processes Program—**Basic mechanisms that initiate, integrate, and regulate physiologic functions in plants and animals. Included are integrative and systems physiology, plant physiology (e.g., phytohormones, environmental stress, water relations, translocation of photosynthates), biorhythms, endocrinology/neuroendocrinology, reproductive biology, receptors, and appropriate intracellular regulatory systems. Investigations at the tissue, organ, and whole organism level using biochemical/molecular, cellular, genetic, and mathematical approaches in elucidating regulatory mechanisms are encouraged.

- **Postdoctoral Research Fellowships in Plant Biology—**Supported by both Cellular Biosciences and Molecular Biosciences, this initiative is designed to encourage a wide range of biological and physical scientists to pursue research careers in the plant sciences, and to let recipients choose research environments that will be most beneficial to their future scientific development. Applicants should present a research proposal that will add to a basic understanding of plant biology at the molecular, cellular, or whole plant level, preferably in a discipline or subfield other than that of their doctoral training.

Molecular Biosciences

- **Biochemistry**—Structure and function of biomacromolecules, with emphasis on understanding the chemical and physical basis for interactions and the mechanisms of the resulting processes. Areas include nucleic acids, proteins, enzymology, lipids and carbohydrates. Studies are considered on the mechanism and regulation of biosynthesis of these macromolecules; protein and enzyme engineering; molecular basis of recognition between nucleic acids, proteins and other macromolecules; biogenesis, topography, and assembly of membranes; and molecular basis of energy transduction.

- **Biophysics**—Studies of the structure, dynamics, and interactions of biologically important macromolecules utilizing physical techniques; relationship of structure to function; changes and alterations in physical and chemical properties of these molecules that occur during the functional state; supramolecular structure; energy transduction and electron transfer in biological macromolecules, systems, and assemblies.

- **Genetics**—Supports a wide range of studies on the organization, characterization, function, evolution, recombination, regulation of expression, and transmission of heritable information in all organisms, from microbes through yeast to animals and plants. Studies of the genetics of viruses and host-parasite interactions are also considered.

Biotic Systems and Resources

- **Biological Research Resources**—Support for the curating, refurbishment, and computerization of systematic research collections of preserved plants, animals, and fossils whose maintenance will conserve an essential scientific resource at the national or international level. Also, support for the publication of major taxonomic revisions and monographs in systematic biology that are based on research which received funding from NSF.

- **Ecology**—Community ecology of land and inland waters with emphasis on species interactions and co-evolution in natural and agricultural ecosystems; microbial ecology of soil and freshwater, especially in relation to community structure and functions; complex community interrelationships involving indirect effects and varying scales in time and space; influences on the distribution and abundance of animal and plant communities both now and in the recent geological past.

- **Ecosystem Studies**—Field, laboratory, and mathematical modeling studies of the processes and components of natural, managed, and human-dominated terrestrial, freshwater, and wetland ecosystems; new methods of predicting ecosystem change and mathematically analyzing functional interdependencies in complex, highly variable systems; information on ecosystem management and exploitation.

- **Population Biology and Physiological Ecology**—The ecological/evolutionary basis for variation in life history, physiological, and behavioral characteristics of plants and animals in terrestrial and inland water environments, and mechanisms by which individual traits are translated into characteristics of populations; the genetic basis for adaptive traits; molecular and quantitative population genetics; physiological, behavioral, and population ecology.

- **Systematic Biology**—The identities, relationships, and distributions of living species of plants, animals, and microorganisms; studies of fossil species to determine changes in biotic diversity through the earth's history; improved methods of gathering, processing, and analyzing systematic data; functional morphology; molecular phylogenetics.

- **Fellowship Opportunities in Environmental Biology for Ph.D.s**—To promote particularly innovative and creative efforts in any of the areas included in the normal purview of its programs, the Division of Biotic Systems and Resources makes available a number of awards to doctoral-level scientists. Such awards serve to foster enhancement of technical proficiency, association with novel intellectual environments and institutions, prolonged tenure at field sites and/or in foreign countries, and development of scientific personnel in underdeveloped disciplinary subfields.

Behavioral and Neural Sciences

- **Anthropology**—Research in cultural anthropology, archaeology, and physical anthropology; on all topics, techniques, and geographic areas. Support for preserving and increasing research accessibility of systematic anthropological collections, and for archaeometric research and laboratories. Support for advanced methodological training is offered in cultural anthropology.

- **Biological Basis of Behavior**—Laboratory and field research on all biological factors that underlie the behavior of animals, and the study of animal behavior per se. Research on genetic, environmental, hormonal, neural, and developmental determinants of behavior, along with the physiological and anatomical mechanisms involved in motor behavior. A special emphasis is directed toward understanding the neural and neuroendocrine factors responsible for the processes of learning and memory.

- **Language, Cognition, and Social Behavior**—Psychological and linguistic research in the laboratory and in the field in all areas of human social, linguistic, and cognitive behavior, and the development of behavior in children. Includes the areas of perception, attention, learning, memory, thought, concept formation, attitude formation, personality, emotion, interpersonal processes, social cognition, and social influence. Also includes research on the syntactic, semantic, phonological, and phonetic properties of individual languages and of language in general; psychological processes in the production and perception of speech; and the biological foundations of language, cognition, and social behavior.

- **Neuroscience**—Research on all aspects of nervous system structure, function, and development. Included is research on the factors that influence the formation, growth, and aging of the nervous system; how neurons and glia differentiate and regenerate, and their biochemical and biophysical properties; the generation and transmission of signals by the neuron; molecular, cellular, and physiological mechanisms involved in sensory transduction, neural coding and information processing; and the pathways and mechanisms that process neural activity.

Social and Economic Science

- **Decision, Risk, and Management Science**—Fundamental research on decisionmaking, management, and operational processes to build a body of knowledge that can be drawn upon to improve practice. Research is characterized by modeling, empirical observation, generalizability of results, and concern with social, behavioral, and organizational factors. This includes explanatory, descriptive, and normative research on operation processes, choices under risk and uncertainty, and the management and design of complex organizations.

- **Economics**—Theoretical and empirical studies, including microanalysis of economic aggregates; forces determining the path of the economy over time in response to various stimuli; determinants and consequences of market structure and different regulatory regimes; interaction of fiscal and monetary variables in open economies, particularly as they pertain to problems of inflation and unemployment; economic study of renewable and non-renewable resources; political economy and nonmarket decisionmaking; labor economics and human relations; economic history and development; international economics; techniques of quantitative analysis; empirical validation and assessment of different types of economic models; and mathematical economics.

- **Geography and Regional Science**—Research on the causes and consequences of the locations of economic, social, cultural, and physical phenomena, including resource use and physical geography; patterns and processes of regional growth and decline; locational behavior and locational decisionmaking; cartography, geographic information systems, remote sensing; research methods; and settlement and settlement systems.

- **Law and Social Science**—Fundamental research on the processes affecting compliance and the impact of law; causes and consequences of variations and changes in legal institutions; personal, social, economic, and cultural conditions affecting use of and responses to law; dynamics of disputing and dispute resolution; determinants of legal decisionmaking; effects of and factors accounting for administrative rule making and regulatory behavior; patterns of social control and deterrence; processes that influence the development of law and explain the relationship between legal processes and other social processes.

- **Measurement Methods and Data Improvement**—Survey operations research; methods and models for the quantitative analysis of social data; improvements in the scientific adequacy and accessibility of social statistical data, including those generated by government as well as the academic research community; applications of cognitive science and information science to social measurement.

- **Political Science**—Research on local, national, and international governmental institutions; the effects of structural factors on political participation and effectiveness; national election studies; the impact of economic and social change on political processes; factors influencing bureaucratic decisionmaking and policy formulation; processes of conflict and political instability.

- **Sociology**—Basic research designed to build and test theories of social processes, human social organization, demography, and individual and institutional change. Support for primary data collection and secondary data analyses and both micro and macro analyses of social differentiation and stratification, social institutions (such as family and religion); occupations and labor force participation; organizations and organizational behavior; population dynamics; social mobility; socialization; gender roles; and the sociology of science and technology.

Instrumentation and Resources

- **Instrumentation and Instrument Development**—Acquisition of major items of specialized, multiuser instruments. The instrumentation must be used in the conduct of basic research in the sciences that fall within the purview of the NSF Divisions of Biotic Systems and Resources, Behavioral and Neural Sciences, Social and Economic Science, Cellular Biosciences, Molecular Biosciences. Development of new instruments that will increase the accuracy, range, or sensitivity of appropriate research observations, or provide new techniques or software development to enhance current instrumentation; and workshops in emerging areas of instrumentation or instrument development.

- **Special Projects**—Instrumentation Facilities for the Biological and Behavioral Sciences provides funds to a department, group of departments, or group of investigators for multiple items of expensive, shareable instruments; core support for interdisciplinary biology groups and cooperative research efforts.

Biological Field Station and Marine Laboratory provides funds for facility refurbishment, rehabilitation, enhancement or construction, including improvements to facilitate disabled scientists.

Living Organism Stock Centers provides funds for seed and stock centers, cell lines, and clone banks as essential national or international scientific resources.

Computational Life Science and Scientific Databases for BBS research areas provide funds for the design and development of biological information resources and databases; algorithms and software related to the management and analysis of information resources; collaborative interdisciplinary efforts in software development for research problems with broad importance for the life sciences and other aspects of computational life sciences; workshops, training, and collaborations with computer scientists to facilitate use of data and software resources.

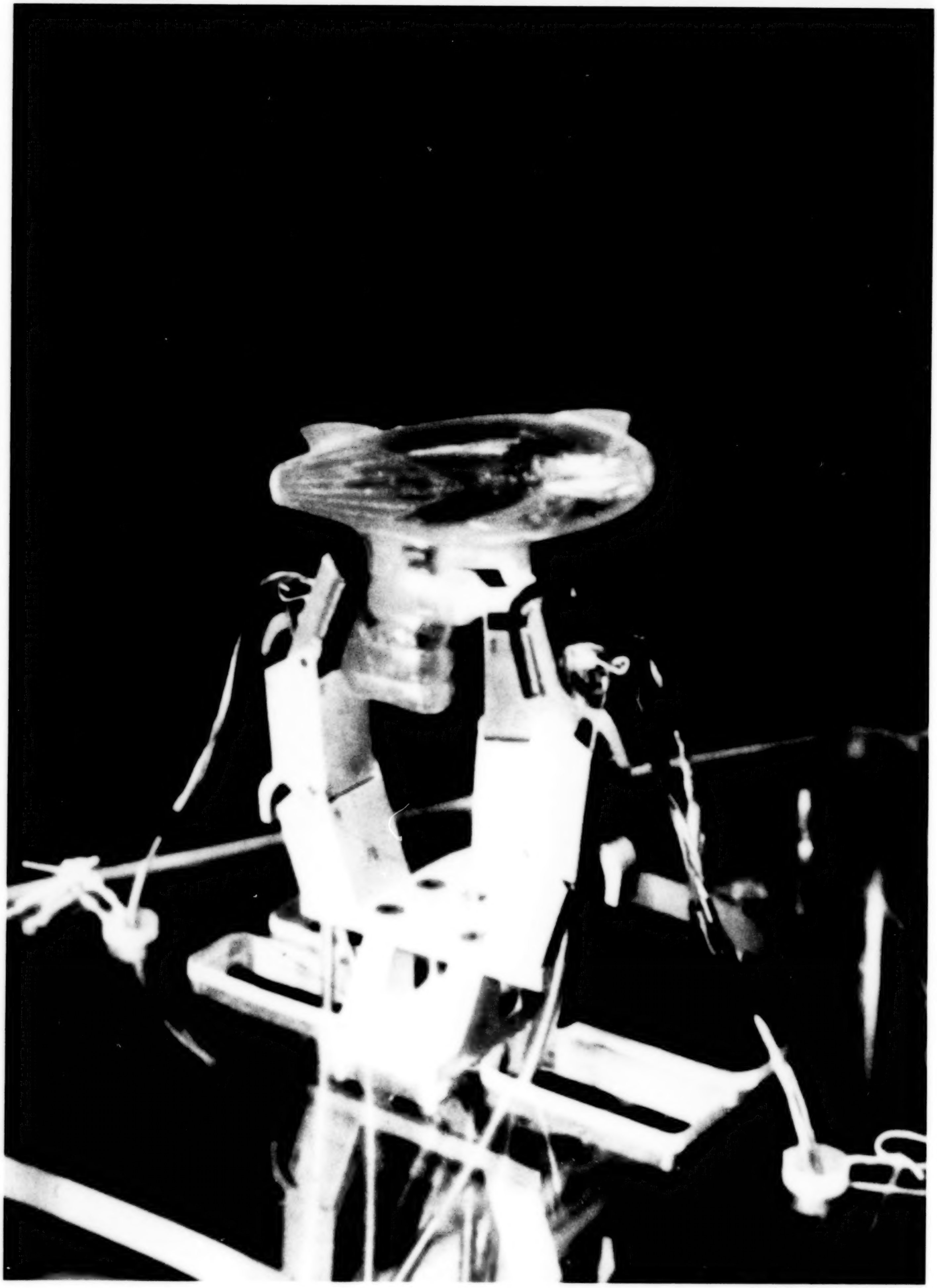
- **Studies in Science, Technology, and Society**—Interdisciplinary, historical, and philosophical research on the intellectual, ethical and value contexts that govern the development and use of science and technology. Includes research and education on the ethical, value or societal issues of current significance to U.S. science and engineering; research on the nature and processes of science and technology development; fellowships for further training and research by recent Ph.D.s specializing in areas of science, technology, and society (STS); and development awards to established scholars, scientists, or engineers to improve their STS skills.

Table 1—Biological, Behavioral, and Social Sciences

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Molecular Biosciences	$ 48.04	$ 51.96
Cellular Biosciences	57.33	63.08
Biotic Systems and Resources	66.71	73.38
Behavioral and Neural Sciences	45.84	49.06
Social and Economic Science	32.26	35.49
Instrumentation and Resources	38.46	43.23
Science and Technology Centers	4.90	11.33
Total	$293.54	$327.53

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).



2

COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

The Computer and Information Science and Engineering (CISE) Directorate's programs improve fundamental understanding of "computing and information processing" in the broadest sense of the terms, enhance the training of scientists and engineers to contribute to that understanding, and encourage and facilitate the use of state-of-the-art computational techniques in scientific and engineering research. Computing and information processing includes the creation, representation, storage, transformation, and transmission of information. Special attention is given to the computing and communications technologies—including software—employed to manage these processes, and to selected generic areas of application. Parallel processing, automation and robotics, large-scale integrated electronic systems, scientific computing, and networking are current areas of emphasis.

CISE is inherently multidisciplinary, supporting not only computer and information scientists and engineers, but also electrical engineers, mathematicians, artificial intelligence and cognitive scientists, and behavioral, economic and social scientists. Its fields are unique in combining science and engineering methods and in the close coupling of basic and applied research methods. Support is provided through individual, group and center research awards, instrumentation grants, research initiation grants, and infrastructure improvement grants to academic institutions.

In addition to supporting research, CISE provides access for the general scientific community to very advanced computing and networking capabilities. National supercomputer centers give access to extremely powerful computing resources, train users, and develop the required software for effective use. Networking activities build and offer a national infrastructure for computer and human interaction and communication for research and education. CISE also supports capabilities for rapid prototyping of microelectronic components and systems for research and education. In addition, CISE supports educational development through such activities as the Educational Infrastructure and Educational Supplements programs.

Scientists and engineers initiate proposals which are usually submitted on their behalf by their employing institutions. The Foundation welcomes proposals from all qualified scientists and engineers, and especially encourages those initiated by women, minorities, and the disabled.

The most frequent recipients of support for basic projects are colleges, universities, and nonprofit research organizations. In special cases, as noted in this *Guide's* introduction, grants also go to other types of institutions and individuals. In these cases, before a proposal is submitted, preliminary inquiry should be made to the appropriate program officer.

Support may be requested for projects involving one or more researchers. Awards are made for projects in a single discipline as well as those that cross or merge disciplinary lines.

A robotic hand at the University of Pennsylvania undergoes tactile sensing tests using a plastic squirt gun.

Deadlines

Proposals may be submitted at any time unless otherwise noted, and six months should be allowed for processing. To be funded in a particular fiscal year (ending September 30), proposals should be received by NSF no later than December of that fiscal year.

For More Information

Additional details or answers to specific questions may be obtained by contacting the appropriate division director, National Science Foundation, Washington, D.C. 20550.

Areas of Research

Several CISE programs described below—Institutional Infrastructure, Instrumentation, Educational Infrastructure, and Research Initiation—cover all fields of computer and information science and engineering, and are managed on a cross-divisional basis.

Computer and Computation Research

- **Computer and Computation Theory—**Basic research on fundamental structures and algorithms of computer science. Topics include new, faster algorithms for a variety of conventional and novel computers; new techniques to analyze the complexity of algorithms; new insights into the fundamental nature of parallel and sequential computation; and other theoretical problems concerned with the foundations of computer science.

- **Computer Systems Architecture—**Research in new architectures, parallel computation, interconnection networks, load balancing, performance evaluation, fault tolerance and graphics. Areas of emphasis include new architectures and architectural paradigms, new design methodologies and modeling tools, comparative evaluations of architectures, and new graphics systems.

- **Numeric and Symbolic Computation—**Algorithms and software for computational science and engineering. Topics of emphasis include symbolic computation and areas of intersection between scientific computing and other parts of computer science such as new, faster algorithms for conventional and new architectures including supercomputers; new software systems; algorithms; libraries; and user interfaces for scientific computing.

- **Software Engineering—**Research to develop well-defined methods, supported by appropriate tools, to produce high quality software products to specification. Research topics include empirical studies of software artifacts and development processes; design representations; analysis techniques; and development tools and environments.

- **Software Systems—**Research fundamental to the design of programming languages for new or improved means of software creation, development and evaluation of operating systems, and validation of correctness and compliance. Topics include new languages, development tools, compilers, interpreters, and prototyping environments; increased understanding leading toward efficient use of parallel systems; and algorithms and methodologies for various purposes.

- **Software Capitalization—**Promotes reuse and sharing of research software among investigators to enhance the research software base. Awards or supplements to distribute and share demonstrably useful non-commercial research software. Examples of eligible products include data analysis and reduction, simulation, program development, performance monitoring and evaluation and computational science.

Information, Robotics, and Intelligent Systems

- **Database and Expert Systems**—Research fundamental to the design, development, management, and use of database and knowledge-based systems. Research topics include conventional databases, scientific databases, and knowledge-base extensions, database support in distributed systems, expert systems, and information retrieval.

- **Information Technology and Organizations**—Research fundamental to the design and use of computer and communications systems to coordinate work and decisionmaking. Research topics include theory and models of information processing in organizations; information systems in environments of networked, decentralized computing; and social impacts and policy implications of information technology in the United States and in regard to international trade and development.

- **Interactive Systems**—Research fundamental to the design of systems that can assist or enable users to perform information-based work. Research topics include the logical structure of the user system dialogue, the cognitive and machine processes on which the dialogue rests, methods of systematic dialogue and interface design, logical relations to be realized across a user-system interface, interaction modalities through which this can be done, and the methodological problem of arriving at valid empirical generalizations about user-system interaction.

- **Knowledge Models and Cognitive Systems**—Research fundamental to knowledge representation and to the design of computer systems for reasoning and problem solving. Research topics include formal models of information, knowledge, and reasoning; natural language processing; and cognitive systems, problem solving, and learning.

- **Robotics and Machine Intelligence**—Research fundamental to the design of systems capable of implementing some of the characteristics of intelligence. Research topics include pattern recognition, machine vision, speech understanding, sensor-based control in intelligent robots, and automatic reasoning and planning of complex tasks involving temporal and spatial relationships in robotic or other computer systems.

- **NSF-ICOT Visitors Program**—Under an agreement between NSF and the Japanese Institute for New Generation Technology (ICOT), U.S. computer scientists and engineers and researchers in allied fields may apply to conduct research at ICOT for a period ranging from six months to one year. NSF funds may be requested to cover salary, costs of travel to and from ICOT, and reasonable living expenses for the applicant and family.

Microelectronic Information Processing Systems

- **Design, Tools, and Test**—Supports research that explores designs processes for both integrated (IC) circuit chips and IC circuits. Emphasis on automating the design process in new, existing and mixed technologies. Research areas include theoretical foundations of IC chip and system design, including models, algorithms and methodologies; tools and frameworks for designing IC chips and systems; design synthesis including logic synthesis and silicon compilation;

methods for simulation of designs; and design testing and validation.

- **Systems Prototyping and Fabrication**—Supports research on technologies and methodologies of prototyping of experimental information-processing systems, including new packaging techniques such as multichip modules, and the basic research necessary to model, simulate, measure, automate and improve the microfabrication process. Microelectronic systems research focuses on interfacing and standards. Support of microelectronics education includes workshops, conferences, development of curricular and courseware materials, and educational support services such as those for FGPAs and fabrication (MOSIS).

- **Microelectronic Systems Architecture**—Supports basic research on computing systems and methods for their design. Computing systems deal with computer architecture, hardware implementation, system software, networking, and data storage. Research is encouraged on the fundamental aspects of computing systems architectures and scientific design methods that better utilize existing or emerging technologies, support systems software or address important applications whose computational requirements cannot be met by conventional architectures. The program emphasizes physically realizable systems and, when necessary, limited proof-of-concept prototyping.

- **Circuits and Signal Processing**—Supports research on circuit theory and analog and digital signal processing. Emphasizes modern signal processing, stressing the impact of VLSI, including signal representation, filtering, novel algorithms, special-purpose hardware, and real-time computing. Circuit theory research encompasses such activities as nonlinear, discrete-time, analog and hybrid circuits, and analog/digital conversion.

- **Experimental Systems**—Experimental research (hardware and software) on the design, construction, test, evaluation, and use of novel computer and information-processing systems. As the test bed for promising application-specific and general purpose architectures, proposed working prototypes should represent new architectures and applications.

Advanced Scientific Computing

- **New Technologies**—Supports algorithm and software development for high-performance computing for use in the solution of scientific and engineering problems. Supports interdisciplinary teams and groups of scientists and engineers working jointly with computer scientists and mathematicians. Research products may be new scientific software, more powerful numerical models, performance evaluation, novel approaches to problem solving through parallel processing, vectorization, and visualization.

- **Postdoctoral Research Associateships in Computational Science and Engineering**—Provides support across all NSF disciplinary areas for young scientists to conduct research at academic research institutions using high performance computing systems.

- **Supercomputer Centers**—Provides scientists and engineers access to high performance computers or supercomputers at four national supercomputer centers. These facilities are dedicated to serving long-term needs, including training for the use of advanced computing by the academic research community. Facilities are continually updated. Descriptions of facilities are available from this division. Proposals for access may, at the researcher's option, be directed either to a center or to the appropriate NSF project support program. In addition, this division may provide support for unique computational resources not available at the supercomputer centers.

Networking and Communications Research and Infrastructure

- **Networking and Communications Research**—Research in communications and information theory, including coding, source coding, multiuser theory, advanced concepts in signal identification and tracking, and innovative approaches to communications and storage such as combined modulation and coding and the design of new algorithms for signal processing and signal detection and parameter estimation. Research on networks, especially very high-speed networks, including architectures, management, protocols, fiber-optic networks, security and survivability, and internetworking.

- **NSFNET**—Encourages and facilitates scholarly communication and collaboration by providing widespread access to other researchers, supercomputer centers, and unique resources through use of wide-area computer networks. Supports expansion, operation and use of the NSFNET backbone connecting the NSF-funded supercomputer centers and midlevel networks. Assists state and regional networks; and funds institutional connections, including both universities and undergraduate colleges, to midlevel networks. Emphasizes collaboration and interoperation with other governmental networks. Provides gateways for access to academic and government networks internationally. Supports promising developmental and demonstration networking projects deriving from networking and communications research.

Cross-Disciplinary Activities

- **Educational Infrastructure**—Supports the design, development, and testing of innovative approaches for increasing the effectiveness of the undergraduate learning experience in computer and information science, computer engineering, or computational science. Provides support for curriculum development, faculty enhancement, development of software and other educational materials, equipment acquisition and maintenance, necessary support staff, and other appropriate costs.

- **Institutional Infrastructure**—Support to enhance research capabilities in computer and information science and engineering by providing experimental research facilities, professional and technical staff, and equipment maintenance costs. In addition to the original Large-Scale element, this program also includes the Small-Scale and Minority Institutions elements. Academic institutions having an existing base for development, including those with predominantly minority enrollments, are strongly encouraged to discuss possible proposals with the program director before submitting a proposal.

- **Instrumentation—**Support for the purchase of special-purpose equipment for research in all fields of computer and information science and engineering. The equipment should be necessary for the pursuit of specific research projects, be needed by more than one project, and be the kind of equipment that would be difficult to justify for one project alone. The total cost must be at least $20,000. Significant cost-sharing is required (usually at least one-third of the total cost). Proposal submission deadline is the first Monday in August.

- **Research Initiation Awards—**Provide an opportunity for tenured or tenure-track faculty members in all areas of computer and information science and engineering to initiate academic research. Proposers compete for funding only with each other and not with more experienced researchers who have had prior Federal research support. The goals of the program are to encourage faculty to begin their research careers and to make an academic research career more attractive. Individuals who have received previous research support from a Federal agency are ineligible. More information may be obtained from the relevant research program director.

- **Other Cross-Disciplinary Activities—**The Office of Cross-Disciplinary Activities also coordinates and/or manages within CISE other cross-divisional targeted activities—including the Presidential Young Investigators, Minority Research Initiation, Faculty Awards for Women, Instrumentation and Laboratory Improvement, Research Experiences for Undergraduates, Ethics and Values Studies, and similar programs. Foundation-wide announcements are available on these programs and should be consulted for deadline dates, proposal formats, and other requirements.

Table 2—Computer and Information Science and Engineering

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Computer and Computation Research	$ 21.98	$ 24.28
Information, Robotics and Intelligent Systems	19.98	22.88
Microelectronic Information Processing Systems	16.61	18.87
Advanced Scientific Computing	62.83	62.58
Networking and Communications Research and Infrastructure	22.19	31.29
Cross-disciplinary Activities	19.63	24.03
Science and Technology Centers	6.57	9.32
Total	$169.79	$193.25

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).

3

EDUCATION AND HUMAN RESOURCES

This Directorate has five major long-range goals:

- To help ensure that a high-quality school education in science is available to every child in the United States, sufficient to enable those who are interested and talented to pursue technical careers at all levels, as well as to provide a base for understanding by all citizens.
- To help ensure that the educational pipelines carrying students to careers in science, mathematics, and engineering yield sufficient numbers of well-educated individuals to meet the needs of the U.S. technical workforce.
- To help ensure that those who select scientific and engineering careers have available the best possible professional education in their discipline.
- To help ensure that opportunities are available at the college level for interested nonspecialists to broaden their science backgrounds.
- To support informal science education programs and to maintain public interest in, and awareness of, scientific and technological developments.

These goals are the mission of the directorate's six divisions/offices, described below:

Research Career Development

This division aims to assure a steady flow of talented science and engineering students from all sectors and regions through the nation's educational and research training systems. Specific activities include:

GRADUATE FELLOWSHIPS

The Graduate Fellowships program promotes the future strength of the nation's scientific and technological base by offering, each year, recognition and three years of support for advanced study to approximately 900 outstanding graduate students in all fields of science and engineering, including 65 awards under the Women in Engineering component.

Eligibility

To be eligible for this nationwide merit competition, candidates must be citizens or nationals of the United States and at or near the beginning of their graduate study. For FY 1991 awards, the stipend for each fellow is $13,500 for a 12-month tenure; an annual cost-of-education allowance of $6,000 is made available to the awardee's institution for each year of tenure, in lieu of tuition and fees.

Deadlines and Additional Information

The deadline for applying is November 9, 1990. NSF will notify all applicants as to the outcome of their applications in mid-March 1991.

A detailed program description and guidelines for application are in the brochure *Graduate Fellowships Announcement* (NSF 90-61). Contact the Fellowship Office, National Research Council, 2101

Plasma sculpture in Discovery Place Physics Theatre, Discovery Place, N.C.

Constitution Avenue, Washington, D.C. 20418. (202) 334-2872.

MINORITY GRADUATE FELLOWSHIPS

This program, open only to members of ethnic minority groups who are underrepresented in the nation's science talent pool, is similar to the Graduate Fellowships program. The program will offer approximately 200 Minority Graduate Fellowships, including 15 Awards under the Women in Engineering Component.

Eligibility

Competition in this program is open to underrepresented minority citizens or nationals of the United States who are American Indian, Black, Eskimo or Aleutian, Pacific Islander, or Hispanic, and who are in the early stages of their graduate study.

Deadlines and Additional Information

The deadline for applying is November 9, 1990. NSF will notify all applicants as to the outcome of their applications in mid-March 1991.

A detailed program description and guidelines for applicants are in the brochure *Minority Graduate Fellowships Announcement* (NSF 90-62). Contact the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418. (202) 334-2872.

NATO POSTDOCTORAL FELLOWSHIPS IN SCIENCE

At the request of the Department of State, NSF administers a program of NATO Postdoctoral Fellowships to promote a closer collaboration among the scientists of member nations. Approximately 50 awards are made each year to outstanding individuals near science or engineering doctoral attainment.

Eligibility

U.S. citizens who have received their doctorates within the past five years may study or conduct research in other NATO countries. The program provides a monthly stipend of $2,000, plus dependency and travel allowances, for tenures of 6-12 months.

Deadlines and Additional Information

Applications must be postmarked no later than November 3, 1990. Fellowship awards will be announced in late February 1991. A detailed program description and guidelines for applications are in the brochure *NSF-NATO Postdoctoral Fellowships in Science* (NSF 90-90). Contact the Division of Research Career Development, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550 (202) 357-7536.

TRAVEL GRANTS FOR NATO INSTITUTES

The Foundation awards travel grants, normally covering the round trip economy air fare involved, to enable young U.S. scientists to attend certain NATO Advanced Study Institutes abroad. These meetings are usually held during the summer and last two to three weeks.

Eligibility

The director of a NATO Advanced Study Institute may nominate U.S. citizens who are graduate science students or have received a Ph.D. within the past three years and have been accepted at a NATO institute. Lists of institutes appear in the final January editions of *Nature*, *New Scientist*, *Science*, and *La Recherche*.

PRESIDENTIAL YOUNG INVESTIGATOR AWARDS

The National Science Foundation offers cooperative research support each year to approximately 200 of the nation's most outstanding and promising young science and engineering faculty. High-ability scientific and engineering researchers receive $25,000 plus an additional $37,500 on a dollar-for-dollar basis if matched with contributions from industrial sources, resulting in total possible annual support of $100,000. Awards will be made for up to five years.

Eligibility

U.S. institutions granting degrees in fields supported by the Foundation may nominate U.S. scientists and engineers who are faculty members in the early stages of their potential careers, received their Ph.D. degree after 1984, and began their first tenure-track positions at eligible institutions after April 30, 1987.

Deadlines and Additional Information

The application deadline for fiscal year 1991 awards is October 1, 1990. Next year's deadline will be announced in the NSF *Bulletin*. For program announcement, contact the Presidential Young Investigator's Awards Program, National Science Foundation, Washington, D.C. 20550. (202) 357-9466.

YOUNG SCHOLARS

This program offers funding for enrichment activities in science, mathematics, and engineering for high-potential or high-ability secondary school students to encourage or reinforce their interest in science careers. Approximately 80 new projects will be funded in FY 1991.

Eligibility

Proposals may be submitted by colleges or universities, their associations or consortia, scientific or professional societies whose members are primarily university faculty or researchers, and for-profit industries or other organizations which are engaged in significant advanced research efforts and have experience in interacting with students.

Deadlines and Additional Information

The application deadline for fiscal year 1991 awards was August 6, 1990. Next year's deadline will be announced in the NSF *Bulletin*. Award notifications should be made by February 1991. A program description and guidelines for applications are in the brochure *Young Scholars Program Announcement* (NSF 90-29). Contact the Division of Research Career Development, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7536.

Undergraduate Science, Engineering and Mathematics Education

The National Science Foundation's undergraduate programs seek to achieve a permanent, high-quality presence in U.S. undergraduate education that will help to assure the long-term health and vitality of the nation's scientific and technological enterprise. The Education and Human Resources Directorate's Division of Undergraduate Science, Engineering, and Mathematics Education (USEME) serves as a focal point for the NSF-wide mission at the undergraduate level. This office has three principal areas of responsibility:

- Program management and operation for those undergraduate support activities specifically assigned to the Directorate for Education and Human Resources.

- Coordination of the Foundation's undergraduate support activities to assure a cohesive program and consistent policies and procedures.

- Development of better understanding and participation in undergraduate education by academic scientists and their institutions, the states, the private sector, and other federal agencies.

In each of these spheres of activity the Division of Undergraduate Science, Engineering, and Mathematics Education has a leading role, but shares its responsibilities with the other divisions throughout the Foundation.

Within this Foundation-wide initiative, EHR supports these specific activities:

CAREER ACCESS OPPORTUNITIES IN SCIENCE AND TECHNOLOGY FOR WOMEN, MINORITIES, AND PERSONS WITH DISABILITIES

This program housed in the Undergraduate division supplements efforts at the precollege and undergraduate levels to address the underrepresentation of women, minorities, and persons with disabilities in the nation's ranks of science and engineering professionals. There are two subprograms:

- **Comprehensive Regional Centers for Minorities**—Support the establishment of regional centers designed to increase the minority presence in science and engineering and to strengthen such efforts in institutions with significant minority enrollments.

- **Prototype and Model Projects for Women, Minorities, and Persons With Disabilities**—Encourage institutions to create special outreach programs for these target audiences.

Eligibility

Proposals for Comprehensive Regional Centers for Minorities may be submitted by coalitions of U.S. colleges, universities, or other organizations with significant enrollments of minority students in science and engineering and a documented history of commitment to minority concerns. NSF requires proposals to be cooperatively developed among several institutions and/or organizations.

Proposals for Model Projects for Women, Minorities, and Persons with Disabilities will be accepted from any organization with the scientific expertise and facilities to conduct the described activities. They should involve innovative, focused activities with potential wide dissemination and national impact.

Deadlines and Additional Information

Proposers may wish to initiate discussions with the program staff before preparing a proposal for either activity. The target date for submission of proposals is February 4, 1991. A detailed program announcement and guidelines for proposals are in the brochure *Career Access Opportunities in Science and Technology for Women, Minorities and Persons with Disabilities* (NSF 88-126). Contact the Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7051.

COURSE AND CURRICULUM

This program will support the design, development, and testing of innovative approaches for increasing the effectiveness and efficiency of the curricula in undergraduate education. The NSF role is to encourage and support the intellectual effort necessary to restructure the curricula and teaching methods in light of present-day and near-future realities. Three subprograms have been initiated:

- **Undergraduate Curriculum Development in Mathematics: Calculus**—This program will make grants to explore ways of improving the undergraduate calculus curriculum in the first two years of college, to provide for planning projects, and to operate curriculum development projects.

- **Undergraduate Curriculum Development in Engineering: Engineering Education Coalitions**—Responsibility for this program, begun in FY 90 as a cooperative effort between the Directorate for Education and Human Resources and the Directorate for Engineering, will shift to the Engineering Directorate in FY 1991. The program will make grants to plan and develop innovation in curricula, experiment with the implementation of such curricula, assess and evaluate outcomes, and disseminate the results to other educators with common interests. There is currently an initiative to support coalitions of Engineering schools focused on systemic approaches towards this goal.

- **Undergraduate Course and Curriculum Development in Engineering, Mathematics and the Sciences**—This program will make grants to plan and develop curricula for introductory level courses with the goal of improving the learning environment in science, engineering, and mathematics for all students. Grants provide for planning, implementation, assessment, and dissemination of projects at both a comprehensive and individual course level.

Eligibility

Proposals will be accepted from any organization or consortium with a scientific or educational mission.

Deadlines and Additional Information

The target date for submission of proposals for the *Undergraduate Curriculum Development in Mathematics: Calculus* is February 1, 1991. The deadline date for the *Undergraduate Curriculum and Course Development in Engineering, Mathematics, and the Sciences* is October 15, 1990. A detailed program announcement and guidelines for proposals are contained in the brochures *Undergraduate Curriculum Development in Mathematics: Calculus* (NSF 89-82), *Undergraduate Engineering Education Coalitions*, and *Curriculum and Course Development in Engineering, Mathematics and the Sciences* (NSF 89-125 rev 4/90). To receive a copy of these brochures, contact the Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7051. To receive a copy of the Engineering Education Coalitions brochure, contact the Directorate for Engineering at the same address.

INSTRUMENTATION AND LABORATORY IMPROVEMENT

This program supports projects to generate more effective and efficient approaches to laboratory- and field-based instruction. Assisted by substantial cost sharing by the awardee institutions, states, equipment manufacturers, and other elements of the private sector, the program stimulates important laboratory instructional improvements in the nation's colleges and universities.

Eligibility

Faculty from all science, mathematics, and engineering departments of any college or university in the United States or its territories are eligible to compete for these grants.

Deadlines and Additional Information

The closing date for submission of proposals is November 16, 1990. Awards will be announced by late May 1991. A detailed program announcement and guidelines for proposals are in the brochure *Instrumentation and Laboratory Improvement* (NSF 89-79). Contact the Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7051.

UNDERGRADUATE FACULTY ENHANCEMENT PROGRAM

This program supports undergraduate faculty seminars and conferences to provide opportunities for groups of faculty to learn about new techniques and new developments in their fields, through national or regional seminars, short courses, workshops, and conferences.

Eligibility

Proposals will be accepted from any organization with the scientific expertise and facilities to conduct the described activities. Proposals may be submitted for support in any of the fields of science, engineering, and mathematics normally supported by the Foundation. Proposed projects must be justified explicitly by their capacity to enhance participants' teaching activities with undergraduate students.

Deadlines and Additional Information

The target date for submission of proposals for projects beginning in the summer of 1992 is April 15, 1991. A detailed program announcement and guidelines for proposals are in the brochure *Undergraduate Faculty Enhancement Program* (NSF 89-88). Contact the Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7051.

RESEARCH EXPERIENCES FOR UNDERGRADUATES (REU)

REU is supported by all of the Foundation's disciplinary research programs. It provides opportunities for undergraduate students to experience hands-on participation in research or related scholarly activity in the sciences, mathematics, and engineering. The Foundation supports researchers who involve students in either ongoing research (REU Supplements) or special programs (REU Sites).

Eligibility

All U.S. institutions conducting research in the disciplines normally supported by NSF are eligible to apply. Thus, proposals will be accepted from colleges and universities, from such nonacademic research institutions as governmental or industrial laboratories, or from combinations thereof. There is no restriction on the number of proposals that may be submitted per institution. Student participants must be citizens or permanent residents of the United States and its possessions and must be enrolled in a program leading to a bachelor's degree.

Deadlines and Additional Information

Proposals for the support of REU Sites are due no later than October 10 annually. Award notifications will be made by late January.

Proposals for REU Supplements will be accepted at any time, but should be submitted as early in the fiscal year as possible. REU Supplements require two to three months processing time after receipt by NSF.

A detailed program announcement and guidelines for proposals are in the brochure *Research Experiences for Undergraduates* (NSF 88-28). Inquiries about REU may be directed to the relevant NSF research directorate.

Materials Development, Research, and Informal Science Education

This division supports a wide range of projects designed to provide new and improved materials and strategies that can help to increase the quality of, and continuously renew, the nation's educational resources in mathematics, science, and technology. This broad goal translates into four objectives that frame the division's program:

- Expand our understanding of the factors that promote effective teaching and learning of science, mathematics, and technology.

- Stimulate the development and facilitate the use of exemplary educational models and materials that incorporate the most recent advances in subject matter, research in teaching and learning, and instructional technology.

- Encourage informal learning through media programs that reach large audiences efficiently and effectively, museum exhibits and activities that provide direct hands-on experiences, and educational programs that extend science learning into a variety of out-of-school settings.

- Analyze the potential for, and explore the use of, advanced technologies in education.

The division accepts proposals submitted in response to general program announcements and to program solicitations that focus on specific high-priority problems and opportunities. Preliminary discussions with program staff are encouraged, and preliminary proposals are required.

Overall, the division supports research and development projects in these areas:

APPLICATIONS OF ADVANCED TECHNOLOGIES

Research and development on the applications of advanced technologies, particularly the computer, to science and mathematics education. Support is provided for the exploration, development, and proof-of-concept demonstration of advanced computer and telecommunications utilization in education. Among the anticipated products are innovative educational systems, intelligent tutors, authoring systems, problem-solving tools, microworlds, and expert systems that significantly increase the efficiency and effectiveness of instruction at all levels.

INFORMAL SCIENCE EDUCATION

Development of materials and programs that support science, technology, and mathematics learning outside of school. The goal is to provide rich and stimulating environments where individuals of all ages, interests, and backgrounds can, through recreational and avocational activities, increase their appreciation and understanding of principles and issues involving mathematics, science, and technology. Major focus areas are the media, including television, radio, and print; science museums, including science-technology centers, natural history museums, zoological parks and aquaria, botanical gardens and arboreta, and nature centers; and other youth-serving and community organizations.

INSTRUCTIONAL MATERIALS DEVELOPMENT

Development of new or improved materials and strategies that support science, mathematics, and technology instruction in the classrooms of the nation's schools. These include print materials, computer software, video materials, manipulatives, laboratory equipment, and any other materials that assist in instruction. Materials must emphasize both content knowledge and effective strategies for student and teacher learning. The development of prototypes that are attractive to teachers and that can serve as models in the next generation of textbooks is particularly encouraged. The program is especially concerned with innovation as well as issues of implementation and dissemination and encourages cooperative efforts with publishers and school systems.

RESEARCH IN TEACHING AND LEARNING

Basic and applied research on significant factors that underlie effective teaching and learning at all levels. This includes advancing the understanding of how interest and motivation develop in science and mathematics, how students learn complex concepts in science and mathematics, how they learn to apply these concepts effectively in problem-solving situations and in making personal decisions, and factors that are influential in governing participation and performance in school science and mathematics courses. Areas of particular interest include the learning needs of groups that are underrepresented in specific careers, the relationships between teachers' subject knowledge and competence and their performance in the classroom, and the effects and significance of direct experience (i.e., laboratory experiences) in the learning process.

Eligibility

Any institution or organization with a scientific or educational mission may submit a proposal.

Preliminary Proposals

Preliminary proposals are required and may be submitted at any time.

Target Dates for Formal Proposals

Applications of Advanced Technologies: January 1, May 1, and September 1.

Informal Science Education: April 1, August 1, and December 1.

Instructional Materials Development: May 15 and November 15.

Research in Teaching and Learning: February 15 and September 15.

For More Information

Interested parties should study the detailed information in the brochure, *Program Announcement, Materials Development, Research, and Informal Science Education* (NSF 88-29). Contact the Division of Materials Development, Research and Informal Science Education, National Science Foundation, Washington, D.C. 20550. (202) 357-7452.

Teacher Preparation and Enhancement

Teachers are central to education. They serve as models, motivators, and mentors—the catalysts of the learning process. Moreover, teachers are agents for developing, exchanging, and replicating effective teaching materials and methods. For these reasons, education in mathematics, science, and technology can be strengthened only if teachers are adequately prepared, highly motivated, and appropriately recognized and rewarded.

In promoting these goals, the Division of Teacher Preparation and Enhancement follows a dual strategy. First, it seeks to support projects that will directly benefit teachers by making them more competent in the subject matter, more comfortable in its presentation, and more committed to their profession and their pupils. In addition, the Foundation expects that projects will add to the base of knowledge about how teachers can most effectively be prepared and subsequently aided to enhance their capabilities. In short, the Division funds projects that promise to serve the teaching profession effectively while providing prototypes for adaptation and adoption elsewhere.

PRESIDENTIAL AWARDS FOR EXCELLENCE IN SCIENCE AND MATHEMATICS TEACHING

This program, an initiative of the Office of the President of the United States, provides national recognition of outstanding elementary, middle, and secondary school teachers. Each year, two mathematics teachers (one secondary school and one elementary school) and two science teachers (one secondary school and one elementary school) from each state and each of the four jurisdictions listed below are selected for the honor. The program seeks to enhance the status and visibility of the teaching profession by identifying and rewarding exemplary teachers. Awardees are brought to Washington, D.C., for a week of activities and professional interaction. The continuation of this interaction is encouraged, and opportunities for individual and collective leadership are facilitated through the Council of Presidential Awardees in Mathematics and the Association of Presidential Awardees in Science Teaching. Each award is accompanied by an NSF grant for $7500, to be used at the teacher's discretion to improve science and/or mathematics education at the awardee's home institution.

Eligibility

Eligible teachers are those whose primary responsibility is classroom teaching of science or mathematics in a public or private, elementary, middle/junior, or senior high school in any of the 50 states, the District of Columbia, Puerto Rico, the Department of Defense Dependent Schools, or the U.S. Territories (Guam, American Samoa, the Commonwealth of Northern Marianas, and the Virgin Islands). A minimum of five years of teaching experience is required. Teachers can be nominated by colleagues, administrators, students, or parents of students.

Deadlines

The deadline for nomination within each state is usually mid-March. Twelve state/jurisdiction finalists are forwarded to a national selection committee that selects the four Presidential Awardees. For complete information contact: Presidential Awards for Excellence in Science and Mathematics Teaching, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7074.

PRIVATE SECTOR PARTNERSHIPS

This solicitation is intended to encourage partnerships between business and industry, school systems, and other educational institutions to improve the quality of science, mathematics, and technology education in the nation's elementary, middle, and secondary schools. These grants are expected to generate novel approaches and models for improvement of K-12 science and mathematics education by including the intellectual and financial resources of the private sector in partnership with local school systems, colleges, and universities. Together, the partners will analyze needs, develop strategies, and undertake specific activities to improve science and mathematics education in the schools.

Eligibility

Partnerships eligible to submit proposals under this solicitation will consist, at a minimum, of a business (or group of businesses) and one or more school districts that have agreed upon a set of needs for educational improvement in K-12 science or mathematics, and are willing to devote their respective areas of expertise and relevant resources to meeting those needs.

Deadlines

Preliminary proposals are encouraged. Formal proposals must be postmarked on or before January 1, 1991.

For More Information

For guidance on the specifics of proposal submission, proposers should obtain the solicitation *Private Sector Partnerships to Improve K-12 Science and Mathematics Education* (NSF 88- 71). The proposer should also consult either of two brochures, depending upon the type of project being proposed—*Program Announcement, Division of Materials Development, Research and Informal Science Education* (NSF 88-29); or *Program Announcement and Guide, Division of Teacher Preparation and Enhancement* (NSF 87-10). Contact Private Sector Partnerships, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-9466.

SCIENCE AND MATHEMATICS EDUCATION NETWORKS

If the results of innovations in science and mathematics education are to be truly effective on a regional or national scale, it is essential that past and potential participants communicate and collaborate.

The goals of the Networks program are to promote useful dialogue among the various constituencies that make up the science, mathematics, engineering, and education communities and to improve the access of teachers, researchers, administrators, and others to new resources and information. Often, the exchange of ideas will be coupled with consensus building concerning strategies for the improvement of education. Emphasis is on the dissemination of information and the sharing of human and material resources via appropriate mechanisms. These mechanisms may include innovative strategies and new technologies. Projects may create new networks based upon new partnerships or build upon existing collaborative structures.

Eligibility

Any public or private organization or institution with a scientific or educational mission may submit a proposal. Established consortia, local and state education agencies, colleges and universities, professional societies and cultural agencies, business and industry are likely proposers.

Deadlines

Proposals are accepted at any time, and will be acted on within six months of receipt. Brief preliminary proposals are strongly recommended.

For More Information

For detailed descriptions of all programs in this division, more explicit criteria and objectives, and information about preliminary inquiries, see the *Program Announcement and Guide for Teacher Preparation and Enhancement* (NSF 87-10). It should be used in conjunction with *Grants for Research and Education in Science and Engineering* (NSF 90-77). Order both publications from Forms and Publications, National Science Foundation, Washington, D.C. 20550.

STATE-WIDE SYSTEMIC INITIATIVE

It has become more and more apparent to those who are vitally interested in the quality of science and mathematics education that many of the problems are systemic in nature. Programs that address a single element of an education system, such as teacher preparation or materials development or student assessment, while important and useful, do not pursue in a comprehensive way the weakness that may exist.

The goals of the State-Wide Systemic Initiative are to promote a complete and thorough revision of science and mathematics education within a state, to forge state-wide alliances between government, education, and the private sector, and to serve as a catalyst for lasting change and improvement.

Eligibility

The governor of a state, or his/her designee may submit a proposal.

Deadlines

A preliminary proposal is required, as well as the final proposal. For 1990, the respective target dates are July 16 and October 15.

For More Information

For detailed description of this initiative, proposers should obtain the solicitation *Statewide Systemic Initiatives in Science, Mathematics, and Engineering Education* (NSF 90-47). Contact Statewide Systemic Initiative, Directorate for Education and Human Resources, National Science Foundation, Washington, D.C. 20550. (202) 357-7751.

TEACHER ENHANCEMENT

All teachers need opportunities to continue their professional development and renew their career commitments. Well-prepared, successful teachers need to be recognized, to engage in activities that enrich and strengthen the theoretical and practical bases for their teaching, and to actively influence and improve the teaching of their colleagues. Those teachers who, for a variety of reasons, are working with a limited or outdated knowledge of science and mathematics need encouragement and support in upgrading their backgrounds and in adopting improved instructional methods and materials.

The Teacher Enhancement program supports the development of effective approaches and creative materials for the continuing education of elementary, middle, and secondary school mathematics and science teachers. Successful projects emphasize both content and pedagogy, help teachers develop and exercise leadership qualities, and provide opportunities for continuing professional growth and interaction. Typical projects involve intensive summer workshops followed by regular follow-up activities during the next academic year. Teachers often play significant roles in planning and staffing these projects. Among current special interests are projects coordinating technology and modern topics in science and mathematics with exemplary instructional systems.

Eligibility

Any institution or organization—public or private—with a scientific or educational mission may submit a proposal. Among these are colleges and universities, school systems and other educational agencies, professional societies, and other profit or nonprofit organizations. The Foundation especially welcomes proposals that involve the collaboration of teachers, scientists, science educators, and/or representatives of state and local educational agencies, business and industry, and cultural and professional organizations.

Deadlines

Target dates for receipt of proposals are February 1 and August 1; in all cases the starting date for a project should not be earlier than six months after target date.

TEACHER PREPARATION

This program supports the development and evaluation of innovative approaches to the preservice preparation of teachers, creative materials for teacher education, and research on factors affecting the recruitment and preparation of teachers. Projects should emphasize a solid foundation in science, mathematics, and/or technology, and rigorous attention to effective teaching practices, including the use of advanced instructional technologies. Special interests include multi- and interdisciplinary projects and initiatives for recruiting members of underrepresented groups into the teaching profession. Collaborations among scientists, science educators, teachers, and other educational leaders are encouraged in the planning and implementation of projects.

Eligibility

Colleges and universities or other organizations qualified to prepare teachers are eligible to submit proposals. Proposals are welcome from all qualified scientists and science educators, and NSF strongly encourages women and minorities to compete fully in the development of teacher preparation projects.

Deadlines

Target dates for receipt of proposals are April 15 and October 15; in all cases, the starting date for a project should not be earlier than six months after a target date. Brief preliminary inquiries are encouraged.

Studies and Program Assessment

The Office of Studies and Program Assessment (OSPA) serves as a source of data and evaluation information about science, mathematics, and engineering education in the United States, and provides analytical and policy support for the leadership efforts of the Foundation in these critical areas.

OSPA supports projects in these areas:

STUDIES AND ANALYSES

Projects are supported which provide data on national trends and other information that will assist the Foundation and other agencies in developing initiatives to strengthen science, mathematics, and engineering education in the United States.

Proposals funded under this program are intended to (1) provide data of national scope on significant problems and opportunities in science, mathematics, and engineering education that would be useful for policy deliberations regarding the strengthening of such education in the United States; and (2) provide information that will assist in setting priorities and plans for the Foundation's science education programs. Proposals are invited for new data collection as well as for synthesis or secondary analysis of existing information.

Current priorities are in five broad policy areas: (1) participation in science; (2) teacher supply and qualifications; (3) instructional content; (4) educational reforms; and (5) achievement trends.

ASSESSMENT STUDIES

These appraisal activities are designed to inform NSF's science and mathematics education programs and to assist them and the Directorate in program planning.

EHR is beginning a systematic set of studies to gauge, on an ongoing basis, the quality and impact of the Foundation's educational activities. The purpose is to assist NSF in its continuing efforts to enhance the effectiveness of its work. Findings of the studies also will inform outside audiences about implementation of the Foundation's programs.

Priority areas of assessment are: (1) establishing criteria for assessing program effectiveness; (2) identifying characteristics of high-leverage programs; and (3) developing frameworks for relating national trends in education to assessment activities.

Eligibility

Public and private colleges and universities and other universities and associations with an educational mission may submit proposals.

Target Dates

Studies and Analyses and Assessment Studies: Although proposals are accepted at any time, semi-annual target dates of April 1 and October 1 have been established.

For More Information

Detailed program descriptions and guidelines for applicants are contained in the program announcement Office of Studies and Program Assessment (NSF 88-69).

Research Initiation and Improvement

Human Resources Development

NSF activities in Human Resources Development reflect the Foundation's commitment to developing the resources of the scientific and technical (S&T) community as a whole. Some of its programs are centrally managed, while others are distributed throughout the Foundation with the cognizant program officer handling the proposal. Objectives of the programs are:

- To increase opportunities for participation in the nation's S&T enterprise for: investigators who are women, minorities, or persons with disabilities; young persons who are minorities; and faculty from predominantly undergraduate colleges and universities;

- To strengthen the capability of institutions that have significant minority enrollments; and

- To foster comprehensive approaches and build effective coalitions that address the development of scientific and engineering talent nationwide.

While the activities listed below are open to all NSF-funded disciplines, some directorates and/or divisions have additional efforts specifically designed for certain of these target groups. Inquiries should be made to the cognizant disciplinary program director.

WOMEN

Because women are underrepresented in all disciplines, the Foundation has several activities that are specifically directed at increasing the number of women as full participants in the mainstream of the nation's research enterprise.

- **Research Planning Grants (RPG)**—Research Planning Grants are one-time, limited awards for preliminary studies and other activities to strengthen the investigator's planning and proposal writing capabilities to facilitate the development of more competitive NSF research proposals. The awardee is expected to submit a research proposal to NSF after completion of the Planning Grant.

Eligibility

Eligibility is limited to women who: have a doctorate (or have equivalent experience) in an NSF-supported field; hold faculty or research-related positions (tenured or non-tenured) at U.S. institutions; are U.S. citizens, nationals, or permanent residents; and have not served as principal or co-principal investigators on independent federal research awards.

Award Size and Duration

Although usually for 12 months, grants may be funded for up to 18 months, and for a maximum of $18,000. They are not renewable.

Deadlines

The Foundation-wide target date is December 1.

For More Information

Request the publication, *National Science Foundation Research Support for Women Scientists and Engineers.* General inquiries may be made to the cognizant program officer, or to the Coordinator for Research Planning Grants (for women), National Science Foundation, Washington, D.C. 20550. (202) 357-7456.

- **Career Advancement Awards (CAA)**—The goal of the CAA effort is to expand opportunities for women researchers to advance their careers. It is particularly appropriate for independent investigators whose careers are still evolving, or for other experienced researchers who are changing research direction, or who have had a significant research career interruption. For example, an investigator may wish to acquire new skills in an area that will expand her research capability, or to develop an innovative research method in collaboration with another investigator.

Eligibility

The CAA applicant should have had some prior independent research experience as a principal investigator or project leader; have a doctorate (or have equivalent experience) in an NSF-supported field; hold a faculty or research-related position at a U.S. institution; and be a U.S. citizen, national, or permanent resident. Tenure is not an eligibility factor.

Award Size and Duration

Awards are limited to a maximum of $50,000 for usually 12 months; additionally, up to $10,000 for equipment may be requested.

Deadlines

The Foundation-wide target date is December 1.

For More Information

Request the publication, *National Science Foundation Research Support for Women Scientists and Engineers.* General inquiries may be made to the cognizant program officer, or to the Coordinator for Career Advancement Awards (for women), National Science Foundation, Washington, D.C. 20550. (202) 357-7456.

- **Research Initiation Consideration**—Proposals from women who have not had previous independent federal research funding, and who submit standard research proposals through regular disciplinary channels, may be given some special consideration by the program officer in the final evaluation process. Since this consideration is for standard proposals only, there are no set-aside funds. Address the request for Research Initiation Consideration to the cognizant disciplinary program officer. (A prospective applicant should discuss the proposed project with the program officer in the research discipline before submitting a formal proposal.)

Eligibility

Eligible women may not previously have served as principal investigators or co-investigators for independent federal research awards, but are eligible for standard NSF research grants.

Deadlines

Proposals should be submitted to the disciplinary research programs in accordance with the deadlines or target dates of those programs.

For More Information

General inquiries may be made to the cognizant program officer or to the Distributed Programs Coordinator, National Science Foundation, Washington, D.C. 20550. (202) 357-7456.

- **NSF Faculty Awards For Women**—To provide recognition for some of the nation's most outstanding women scientists and engineers in careers of research and teaching, women faculty may be nominated by their academic institutions in a competition that will support the awardee's research activities for up to five years. Selection is based upon evaluation of the nominee's ability as a researcher and teacher. Institutions are expected to make a significant commitment to awardee support, including full academic-year salary.

Eligibility

Nominees must be U.S. citizens, nationals or permanent residents; hold a Ph.D. degree in science or engineering (or equivalent); and be a tenured faculty member, but not yet a full professor when nominated. Applicants should consult the most recent program announcement, since there may be eligibility changes for FY 1991.

Award Size and Duration

Annual grants of up to $50,000 per year for up to five years may be made. Support beyond the first year will be contingent upon submission of a satisfactory annual progress report and the availability of funds.

Deadlines

The nomination forms and recommendations from referees must be postmarked no later than September 1.

For More Information

Request the program announcement NSF 90-27. General inquiries may be made to the Coordinator, Faculty Awards for Women, National Science Foundation, Washington, D.C. 20550. (202) 357-5052.

- **NSF Visiting Professorships For Women**—The VPW program provides support to experienced women scientists and engineers who serve as visiting faculty members at host institutions. It enables a female investigator to do research at an academic institution of her choice. In addition to research and teaching/lecturing, the visiting professor undertakes counseling and other interactive activities to increase the visibility of women scientists in the academic environment of the institution, and to provide encouragement for other women to pursue careers in science and engineering.

Eligibility

Women who hold a doctorate (or have equivalent experience) in a field of research supported by NSF, and have independent research experience, are eligible.

Award Duration

The usual award is for 12 months, but other arrangements (one semester to 24 months) are also possible. Applicants may wish to discuss duration arrangements with the program director prior to proposal submission.

Deadlines

Proposals must be postmarked by November 15 of each year.

For More Information

Request the program announcement NSF 90-42. Inquiries may be made to the Program Director, Visiting Professorships for Women, National Science Foundation, Washington, D.C. 20550. (202) 357-7734.

MINORITIES

The Foundation has a number of special programs targeted for members of minority groups that are underrepresented in science and engineering. These groups include: American Indians, Blacks, Hispanics, Native Alaskans, and Native Pacific Islanders (Micronesian and Polynesian). Such efforts include programs for students, faculty, and institutions.

- **Alliances For Minority Participation (AMP)**—The AMP program supports the establishment of comprehensive approaches to increase the quantity and quality of underrepresented minorities successfully completing science and engineering (S&E) baccalaureate degree programs. A goal of the program is to substantially increase the pool of interested and academically qualified underrepresented minority students who go on for graduate study in these fields. This near-term objective facilitates AMP's long-term goal of increasing the production of minority Ph.D.s in S&E fields, including entry into faculty positions. Coalitions of institutions and organizations will design multi-disciplinary and/or disciplinary approaches to achieve the program goals, and will focus upon the undergraduate level. Success will be measured by the ability to bring about significant quantifiable and qualitative enhancements in minority S&E participation. Projects must include activities that affect the students' advancement through one or more of the critical decision points in S&E educational careers, and, thus, build linkages between various sectors of the S&E community. Eligible activities include student enrichment, academic enrichment, curricula improvement, and enhancement of institutions with significant minority S&E enrollment.

Eligibility

Organizations eligible to submit proposals include: non-profit organizations and/or academic institutions, such as major research institutions, historically Black and other institutions with significant minority enrollments, comprehensive universities, and other 2- and 4-year colleges. Since the AMP program requires coalitions that capitalize on the strengths of the various partners, AMP proposals should include colleges and universities, school systems, state/local governments, industry, private foundations, S&E professional organizations, and other federal agencies, as necessary for achieving the program's objectives.

Award Size and Duration

Awards will initially be made for up to 5 years, but they are potentially renewable. The NSF contribution to a project may not exceed $1,000,000 per year.

Deadlines

AMP implementation proposals have a January 31, 1991 proposal submission deadline.

For More Information

Request program announcement NSF 90-44, or contact the Program Director, Alliances for Minority Participation, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

- **Research Careers For Minority Scholars (RCMS)**—The RCMS program is also designed to retain a significant number of underrepresented minority students in the science and engineering pipeline. The program provides support to help universities and colleges implement enrichment programs in science and engineering, and includes stipends to qualified minority science and engineering students so that they can pursue career paths in those fields. Support may be provided for student research experiences, tuition, counseling, mentoring, and other academic enrichment activities. While the goals of the RCMS program are similar to those of the Alliances for Minority Participation (AMP), and its activities may serve as AMP components, RCMS efforts tend to be smaller in scale and more departmentally oriented.

Eligibility

Proposals may be submitted by U.S. colleges and universities on behalf of a minimum of five eligible students. Proposals are particularly encouraged from institutions with significant minority enrollments and a tradition of training minority students.

Award Duration

Grants may be awarded for periods of up to five years.

Deadlines

Proposals may be submitted at any time, but there are two target dates each year, November 1 and February 1. Proposers are encouraged to contact the RCMS Program Director before submission.

For More Information

Inquiries may be made to the Program Director, Research Careers for Minority Scholars, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

- **Research Opportunities For Minority Students and College Faculty**—One means of fostering the full participation of members of underrepresented minority groups in science and engineering is by encouraging talented and promising minority students and college faculty to participate in ongoing research. Utilizing existing NSF supplemental programs, principal investigators with NSF awards may include these persons in their projects as research assistants. Interested parties make their own arrangements; there is no central referral source. Most awards are for summer support, but arrangements may sometimes be made for the academic year.

Eligibility

Participants must be underrepresented minorities who are citizens or nationals of the United States. Eligible students may be at the high school or undergraduate level. Faculty should be employed in U.S. academic institutions, working in any NSF-supported field, and not have the resources for the research at their own institutions.

Award Size and Duration

Supplemental funding may be requested for each participant. Full-time summer stipends for high school students are expected to be at least $1,000, while those for undergraduates should be at least $2,000. Faculty summer support may not exceed two-ninths of the academic year salary. Indirect costs are limited to 25 per cent of the stipends. Support is available for a summer, or, if funding is available, for part-time activities during the academic year.

Procedures for Requesting Support

Requests for funding may be included in an initial proposal submission to NSF. They should include a statement indicating the process by which participants will be selected and a brief description of their participation in the project.

Current NSF grantees are encouraged to request supplemental funding to their existing grants. The appropriate NSF program director should be contacted by the principal investigator at the host institution. The NSF funding programs by participant level are: high school students—Research Assistantships for Minority High School Students; undergraduate students—Research Experiences for Undergraduates; college faculty—Research Opportunity Awards.

For More Information

Request the program announcements: Research Assistantships for Minority

High School Students; Research Experiences for Undergraduates; or Research Opportunity Awards. Inquiries may be made to the cognizant program officer, or to Minority Programs, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

- **Minority Research Initiation (MRI)**—MRI is part of the Foundation's overall effort to give greater access to scientific research support for members of minority groups that are underrepresented in the sciences and engineering. There are three MRI activities under this initiative which is targeted toward increasing the number of minority faculty in mainstream research.

- **Research Planning Grants (RPG)**—Research Planning Grants are one-time, limited awards for preliminary studies and other activities to facilitate the development of more competitive NSF research proposals. The awardee is expected to submit a MRI research proposal to NSF after completion of the Planning Grant.

Eligibility

Eligibility is limited to underrepresented minority scientists and engineers who are eligible for regular NSF research awards in their respective disciplines; hold faculty or research-related positions (tenured or non-tenured) at U.S. institutions; are U.S. citizens or nationals; and have not served as principal or co-principal investigators on independent federal research awards.

Award Size and Duration

Although usually for 12 months, awards may be funded for up to 18 months, and for up to $18,000. The grants are not renewable.

Deadlines

The Foundation-wide target dates are December 1 and March 1. Proposals should be directed to the appropriate disciplinary program through standard institutional channels.

- **Research Initiation Awards**—These are one-time research grants made by the disciplinary programs to provide opportunities to promising minority investigators for enhancing their capability as independent investigators.

Eligibility

Eligibility is the same as for the MRI Research Planning Grants.

Deadlines

Proposals should be submitted to the Foundation's disciplinary research programs in accordance with the target dates or deadlines of the cognizant program. Applicants are urged to discuss the proposed research with the appropriate program officer before submitting a proposal.

Duration

Projects will normally be supported for up to three years. They are not renewable. However, a Creativity Extension Award may be requested for up to two additional years, if warranted by evidence of publications and other outcomes demonstrating the creativity, significance and promise of the research to date, and its potential for the future.

- **Career Advancement Awards (CAA)**—The goal of the CAA effort is to expand opportunities for minority researchers to advance their careers. It is particularly appropriate for independent investigators whose careers are still evolving, or for other experienced researchers who are changing research direction, or who have had a significant research career interruption. For example, an investigator may wish to acquire new skills in an area that will expand his/her research capability, or to develop an innovative research method in collaboration with another investigator.

Eligibility

The CAA applicant should have had some prior independent research experience as a principal investigator or project leader; be eligible for a regular NSF research award in his/her discipline; hold a faculty or research-related position at a U.S. institution; be an underrepresented minority and a U.S. citizen or national. Tenure is not an eligibility factor.

Award Size and Duration

Awards are limited to a maximum of $50,000 for usually 12 months; additionally, up to $10,000 for equipment may be requested.

Deadlines

The Foundation-wide target dates are December 1 and March 1. Proposals should be directed to the appropriate NSF disciplinary program through standard institutional channels.

For More Information

Contact the appropriate disciplinary program officer or the Minority Research Initiation Program Officer, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

RESEARCH IMPROVEMENT IN MINORITY INSTITUTIONS (RIMI)

RIMI supports faculty research and the acquisition of research equipment, along with cooperative research projects between academic institutions and industry, to strengthen the institution's research program and encourage greater student and faculty research involvement.

Eligibility

Proposals may be submitted by scientists and engineers who have full-time appointments at U.S. colleges and universities with significant minority enrollments (defined as more than 50 percent combined minority enrollment; or at least 20 percent of any single underrepresented minority group). These schools must also have graduate programs in science or a baccalaureate program in engineering.

Award Size and Duration

While the proposed amount and duration for requested RIMI support should be consistent with the nature and complexity of the proposed activity, proposals may request up to $500,000 per year per eligible institution in a given fiscal year. Institutions may submit several proposals totaling the maximum amount, or one project for the entire sum. Projects may be supported for up to five years, although initial awards generally will be for a shorter period.

Deadlines

Proposals must be postmarked by December 1 or March 1 of each year.

For More Information

Request the program announcement NSF 89-7. Inquiries may be made to the Program Director, Research Improvement in Minority Institutions, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

MINORITY RESEARCH CENTERS OF EXCELLENCE (MRCE)

One of the major goals of the MRCE program is to increase the numbers of minorities in science and engineering by making substantial resources available to upgrade the capabilities of the strongest and most research-productive minority institutions. This provides increased opportunities for minority faculty and students to engage in meritorious research. At the same time, the program enables these institutions to use their resources and research to increase the effectiveness of related science and engineering activities for other institutions in their regions.

Eligibility

Institutions participating in MRCE are those that have: enrollments of 50 percent or more of minority groups that are underrepresented in science and engineering; graduate programs in NSF-supported fields of science or a baccalaureate program in engineering; demonstrated strengths in NSF-related fields, as evidenced by an existing or developing capacity to offer doctoral degrees in one or more science and engineering disciplines; a willingness and capacity to serve as a regional resource center; and a demonstrated commitment and track record in enrolling and graduating minority scientists and engineers.

Award Size and Duration

MRCE Implementation Awards provide up to $1 million each year for up to five years to design and implement a comprehensive research and training improvement plan. Subsequent funding for additional years may be available, provided a sufficient research quality base has been developed, minority scientists and engineers are being graduated, and there is high potential for continued institutional enhancement in the MRCE-supported disciplines.

Proposal Submission

Currently, six institutions (Howard University, Meharry Medical College, University of Puerto Rico, Alabama A&M University, University of Texas at El Paso, and CUNY City College) are MRCE recipients. In FY 1991, the Foundation will initiate two or three new centers.

For More Information

Contact Program Director, Minority Research Centers of Excellence, National Science Foundation, Washington, D.C. 20550. (202) 357-7350.

PREDOMINANTLY UNDERGRADUATE INSTITUTIONS—RESEARCH SUPPORT

The National Science Foundation encourages faculty research at predominantly undergraduate institutions for several reasons. Such research contributes to the knowledge base in science and engineering. It enhances the scientific and technical training of students by strengthening the environment in academic departments that are oriented primarily toward undergraduate instruction; and it promotes the integration of research and education in these undergraduate institutions.

Predominantly undergraduate institutions include schools which are two-year, four-year, masters-level, and small doctoral institutions. Eligible institutions: (1) grant baccalaureate degrees in NSF-supported fields or provide instructional programs for students pursuing such degrees with institutional transfers; (2) have an undergraduate enrollment exceeding that at the graduate level; (3) have awarded no more than 20 Ph.D.s or D.Sci. in all NSF-supported disciplines during the two previous academic years.

Faculty members from these institutions are encouraged to request support through the standard NSF disciplinary programs, the Research Opportunity Awards (ROA) effort, and (for faculty in the nondoctoral departments) the Research in Undergraduate Institutions (RUI) program.

Funding targets are established for RUI and ROA across all research programs of the Foundation.

RESEARCH IN UNDERGRADUATE INSTITUTIONS (RUI)

RUI provides support for research and research equipment for faculty in nondoctoral departments in predominantly undergraduate institutions. In addition to the usual NSF requirements, RUI proposals must also describe the expected impact of the proposed research on the research and training environment of the department. This impact statement is considered in the proposal evaluation.

Proposals for RUI are accepted in all disciplinary research fields supported by the Foundation. They are evaluated and funded by the NSF programs in the disciplinary areas of the proposed research. Within this context, RUI serves as a vehicle for eligible proposals and is fully integrated into the ongoing research activities of the Foundation.

Eligibility

Proposals may be submitted by faculty in departments that meet both of the following conditions: (1) the submitting institution must be predominantly undergraduate, as defined above; and (2) the department of the principal investigator must offer courses that qualify for bachelor's degree credit in an NSF-supported field, may offer master's degrees, but may not award a doctorate or offer doctoral courses and supervise doctoral research.

Nature of Support

Awards may support research at the home institution, including work in the field, and/or away from the home institution at a research university or government or industrial laboratory. These research awards may include some dedicated instrumentation. RUI also may be used to access the various disciplinary research equipment programs for acquisition of instrumentation essential for faculty research. The latter often requires multiple investigators and matching funds as specified by the disciplinary area.

Award Criteria

Eligible RUI proposals are evaluated in competition with all other proposals submitted to the Foundation in the same area of research, in accordance with the standard merit review procedure for that discipline. However, special RUI reviewer instructions are provided that emphasize the role of research in a RUI institution. The fourth NSF review criterion permits consideration of a RUI proposal in terms of its contribution to the infrastructure of science and engineering research, including training in the sponsoring department and institution. Thus reviewers are asked to especially consider the RUI impact (infrastructure) statement contained in the proposal, as well as to recognize the impact of the heavier teaching loads, limited support personnel, facilities and equipment, and possibly the smaller-scale of the investigator's research.

Deadlines

RUI proposals are submitted to the Foundation's disciplinary programs in accordance with target dates or deadlines of those programs. These dates are published in the NSF Bulletin.

For More Information

Request the program announcement NSF 89-60. Applicants are urged to discuss proposed projects with the NSF program officers in their disciplines. General inquiries may be made to the RUI Coordinator, National Science Foundation, Washington, D.C. 20550. (202) 357-7456.

RESEARCH OPPORTUNITY AWARDS (ROA)

The Foundation provides opportunities for faculty at institutions with limited research opportunities to participate in research under the aegis of NSF investigators at other institutions. Science teachers (middle and high school) who are underrepresented minorities, and who have a keen interest in research, may also participate. Most frequently these are summer experiences.

Faculty members or teachers make their own arrangements with NSF investigators at the universities or laboratories that have been awarded or are currently applying for a Foundation research project grant. Prospective investigators who wish to employ faculty under these arrangements should include the additional requirements in the proposal budget. In the case of ongoing awards, grantees should contact the cognizant NSF program officer and request supplemental funding to permit participation by a visiting ROA researcher. Each case is judged on its own merits and is awarded at the discretion of the NSF program manager. The ROA visiting scientist becomes a temporary employee of the grantee institution at which the principal investigator holds an appointment. Length of employment, the stipend, and other arrangements with respect to employment become matters of individual negotiation between the visiting scientist or engineer from the smaller institution and the principal investigator at the host institution.

For More Information

Contact the appropriate Foundation program officer, or the ROA Coordinator, National Science Foundation, Washington, D.C. 20550. (202) 357-7456.

PERSONS WITH DISABILITIES

NSF encourages persons with disabilities to participate fully in NSF-supported projects.

FACILITATION AWARDS FOR HANDICAPPED SCIENTISTS AND ENGINEERS

The goals of this effort are to help reduce or remove barriers to participation in research and training by individuals with physical disabilities through the provision of special equipment and/or assistance; and to encourage individuals with these disabilities to pursue careers in science and engineering by stimulating the development and demonstration of special equipment that facilitates their work performance. The need for special equipment or assistance must be specific to the NSF project for which it is requested.

FAH requests may be included in research or education proposals submitted to any NSF program office, or in requests for supplements to ongoing awards. Graduate Fellowship awardees or honorable mention recipients may also request FAH assistance. Facilitation Award requests may have additional review by individuals knowledgeable about both the research discipline and the disabling condition.

For More Information

Request program announcement NSF 84-62 (revised). Inquiries may be made to the FAH Coordinator, National Science Foundation, Washington, D.C. 20550. (202) 357-7456. Questions about a specific award should be addressed to the cognizant NSF program officer.

Table 3—Education and Human Resources

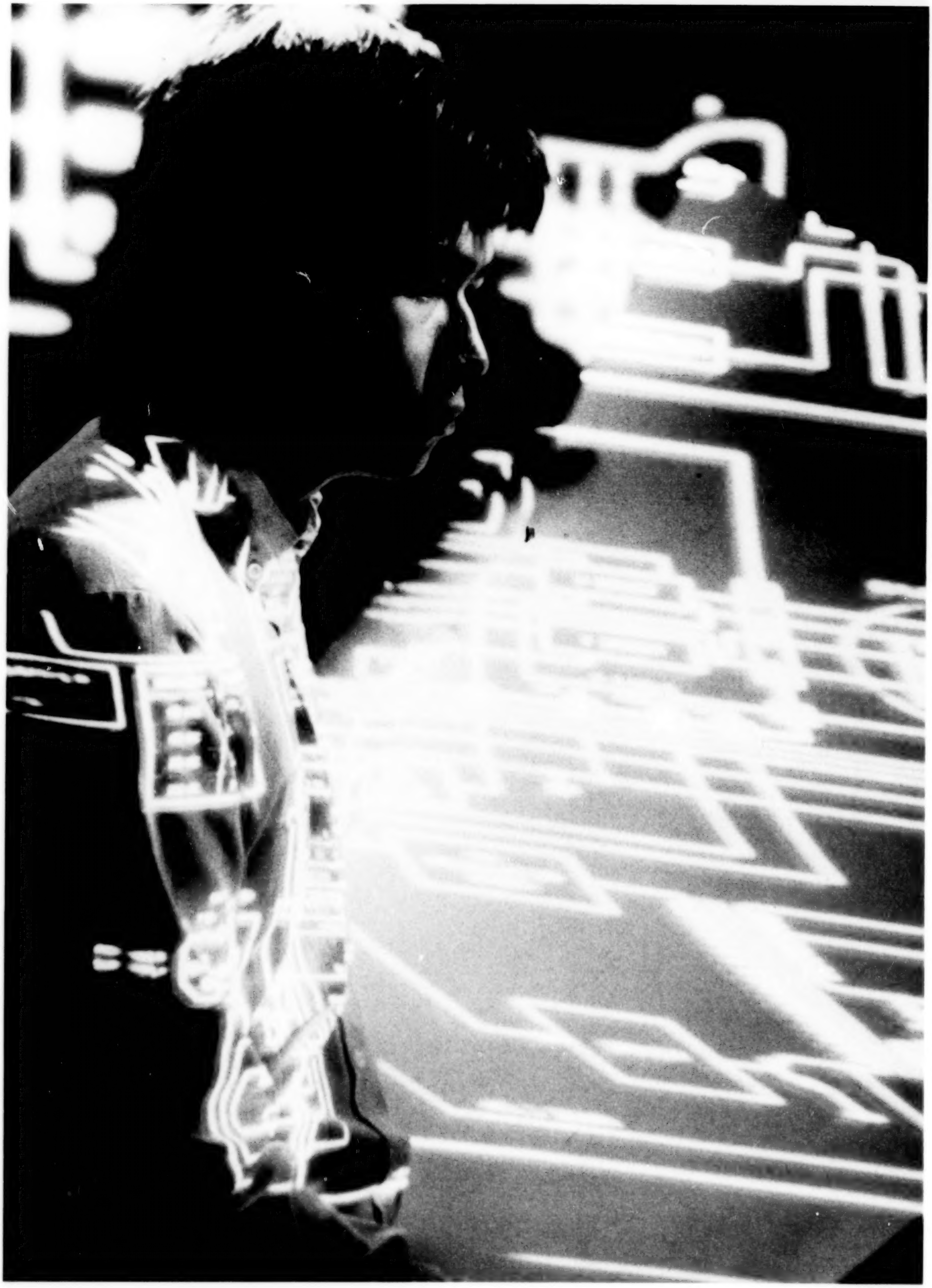
(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Teacher Preparation and Enhancement	$ 81.00	$ 89.60
Materials Development, Research and Informal Science Education	48.00	61.50
Undergraduate Science, Engineering and Mathematics Education	34.00	50.00
Research Career Development	36.90	44.90
Studies and Program Assessment	4.37	5.00
Research Initiation and Improvement*	16.23	22.35
Total	$220.50	$273.35

* Excludes Experimental Program to Stimulate Competitive Research.

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).

This table reflects the June 1990 reorganization of the former Directorate for Science and Engineering Education.



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ENGINEERING

NSF's Directorate for Engineering (ENG) seeks to promote the progress of engineering and technology, thereby contributing to national prosperity and security through its broad and long-range support of engineering research and education. Specifically, the ENG Directorate seeks to:

- Strengthen the engineering science base, which provides the foundation for engineering education, research, technological innovation, and practice;
- Develop a knowledge base for technology-driven areas such as design and manufacturing;
- Encourage technological innovation through the support of research in emerging areas;
- Promote the cross-disciplinary research approach through the support of research groups and centers;
- Improve the quality of engineering education in order to attract the most capable students to the engineering profession and produce first-rate engineers;
- Provide additional opportunities for minorities, women, and the disabled, through programs to remove barriers and provide incentives for full participation in education and research.

To achieve these goals, the Directorate is organized into seven divisions and one office. The Chemical and Thermal Systems Division funds research which strengthens the engineering base for technologies involving chemical, thermal, and flow processes.The Mechanical and Structural Systems Division seeks to improve and expand fundamental engineering knowledge in the broad areas of mechanics, structures, and materials engineering.

The Division of Electrical and Communications Systems directs its efforts toward enhancing the engineering knowledge base for the analysis, synthesis, design, and fabrication of materials, devices, systems, and phenomena that involve electrical, electronic, electromechanical, or optical technologies. A fourth division, Design and Manufacturing Systems, strives to develop and expand the scientific foundations of design, manufacturing, and computer-integrated engineering.

The fifth division, Biological and Critical Systems, is divided into two sections: (1) Bioengineering and Environmental Systems and (2) Hazard Mitigation. The first section is concerned with expanding the knowledge base of bioengineering; improving the ability to cope with threats to the physical environment; and exploring basic engineering problems in the development, conservation and use of ocean resources and systems. The second section seeks to develop a basic engineering understanding of potentially destructive natural phenomena.

The sixth division, Engineering Centers, supports university-based research centers aimed at enhancing our country's industrial competitiveness by strengthening university/industry coupling in research and education.

The seventh division, Engineering Infrastructure Development provides a Directorate-wide focus, as described below.

Eligibility

The most frequent recipients of support for research are academic institutions, although awards are occasionally made to profit making organizations, individuals, and government agencies at all levels.

Most awards result from unsolicited research proposals, which should be prepared according to the guidelines set forth in *Grants for Research and Education in Science and Engineering* (NSF 90-77). In addition to the proposal format described in NSF 90-77, investigators should also include a separate section which describes the impacts of the proposed research. This section should discuss potential new

Computer engineering at the University of South Carolina.

discoveries or advances that are expected as a result of the research and the specific contributions the proposed work will make toward expanding or developing the knowledge and technology base. Reviewers are being asked to provide specific comments on this aspect of the research, including the principal investigator's own assessment of the potential contributions. Researchers are also asked to comment on their results from research previously funded by NSF.

Deadlines and Target Dates

For regular research programs, submit proposals at any time. Those received too late for review in a particular fiscal year (ending September 30) are considered in the following year if the program is continued. If a specific start date for the project is important, clearly explain the circumstances and allow at least six months lead time for review and processing.

For the special programs described above, refer to the NSF *Bulletin* for deadlines and target dates.

For More Information

Contact the Planning and Resources Officer, Directorate for Engineering, National Science Foundation, Washington, D.C., 20550. (202) 357-9774.

Engineering Infrastructure Development

The aim of the Division of Engineering Infrastructure Development (DEID) is to develop and provide a Directorate-wide focus for (1) activities that affect one or more of the divisions of the Directorate for Engineering and that will optimize the effective use of university, industry, and other resources; (2) activities that will advance U.S. engineering through international cooperation; and (3) the activities of the Directorate with respect to engineering education.

DEID is responsible for coordination with other organizations concerned with engineering research and engineering infrastructure, including the Office of Science and Technology Policy, the National Academy of Sciences, the National Academy of Engineering, the National Research Council, foreign research organizations, engineering professional societies, and other parts of the engineering community.

DEID also coordinates the Directorate's effort to increase the participation of women, minorities, and persons with disabilities in NSF engineering programs and activities.

In addition to regular research project support, several special activities are supported to address Engineering's goals:

- **Graduate Engineering Education for Women, Minorities, and/or Persons with Disabilities**—This program was established to encourage women, minorities, and/or persons with disabilities to enter graduate study and research leading to doctoral degrees in engineering. Awards are made directly to academic institutions to provide funds for student support and associated expenses. A program announcement is available.

- **Engineering Education Coalitions**—These multi-university awards draw from a diverse spectrum of engineering programs and are intended to dramatically increase the quality of undergraduate engineering education by disseminating new structures and approaches; creating strong linkages and intellectual exchanges between U.S. engineering schools; and increasing the number of degrees awarded (especially to women, minorities, and persons with disabilities). A program announcement is available for this activity.

- **Presidential Young Investigator Awards**—Cooperative research support is provided to outstanding young engineering faculty to help universities and colleges attract such individuals to academic careers, where they can do research and participate in the education of the nation's future engineers. Support is provided by NSF and industrial firms or private, nonprofit organizations. Program announcements are issued annually.

- **Engineering Research Equipment Grants**—Grants are made for the acquisition or upgrading of research equipment that will provide new research capabilities or improve the quality and broaden the scope of engineering research at academic institutions. Substantial cost sharing is required. A program announcement is available.

- **Support to Predominantly Undergraduate Institutions**—Support is provided through the regular research programs as well as under two special activities: (l) Research in Undergraduate Institutions and (2) Research Opportunity Awards for Small-College Faculty. The goals of these activities are to increase support to institutions where the primary emphasis is on undergraduate education and where research participation is a means to prepare students for graduate study and research careers. A program announcement is available for the two special activities.

- **Research Initiation Awards**—This program provides an opportunity for full-time faculty members without any current or prior Federal research support to initiate academic engineering research. Proposers compete for funding only with one another and not with more experienced researchers. Goals are to encourage faculty to begin their research careers and to make academic careers in the engineering fields more attractive to prospective and existing faculty members. Grants are to be used for the initiation of theoretical and/or experimental research projects in any area normally supported by the Directorate for Engineering.

- **Supplemental Funding for Support of Women, Minority, and Disabled Engineering Research Assistants**—In FY 1991, the Directorate for Engineering will provide additional funding for investigators who wish to include women, minority, and disabled undergraduate or high school students as research assistants on their projects. Supplemental funding of up to $5,000, including indirect costs, may be requested for each student to be added to the project. Funds provided by this program are limited to two students per grant. Up to 10 percent of this amount may be used for supplies and services. The support may be used for a summer, a quarter, or an academic year.

  Additional funds in excess of $5,000 may be requested, if necessary, to provide special equipment, modify equipment, or provide other services required specifically for participation of disabled individuals. The equipment must be specifically related to the research work (e.g., prosthetic devices to manipulate a specific piece of equipment) and not for general assistance (e.g., wheelchairs or ramps).

For More Information

Contact the Staff Associate, Division of Engineering Infrastructure Development, National Science Foundation, Washington, D.C., 20550. (202) 786-9631.

Chemical and Thermal Systems

The objective of this division is to contribute to the knowledge base for a large number of industrial processes involving the transformation and transport of matter and energy. The transformation processes may be chemical, biological, physical, or a combination of these. The industrial processes involve a wide range of technological pursuits and are found in such industries or areas as aerospace, electronics, chemicals, resources, environment, petroleum, biochemical, materials, food, power generation, and allied activities.

Research is supported for the development of fundamental engineering principles, process control and optimization strategies, mathematical models, and experimental techniques, with emphasis on those projects having the potential for innovation and broad application.

Areas of Research

- **Chemical Reaction Processes**—Support of fundamental and applied research on (1) rates and mechanisms of important classes of catalyzed and uncatalyzed chemical reactions as they relate to the design and application of catalysts, chemical processes, and specialized materials; (2) chemical phenomena occurring at or near solid surfaces and interfaces; (3) design and optimization of complex chemical processes; (4) dynamic modeling and control of process systems and individual process units; and (5) interactions between chemical reactions and transport processes in reactive systems.

- **Interfacial Transport and Separation Processes**—This program supports fundamental research in areas related to interfacial phenomena, mass transport phenomena, separation science, and phase equilibrium thermodynamics. Engineering science research in these areas supports various aspects of engineering technology with major impact on chemical and material processing, as well as bioprocess engineering. Research in this program also contributes to the Division emphasis on basic knowledge impacting on physico-chemical hazardous waste treatment and avoidance. The program provides support for new theories and approaches determining the thermodynamic properties of fluids and liquid mixtures in biological and other complex molecules.

- **Fluid, Particulate and Hydraulic Systems**—Support of fundamental and applied research on mechanisms and phenomena governing single and multiphase fluid flow, particle formation and transport, and fluid-particle system characterization. Research is sought which aims at markedly improving our understanding of important engineering processes or phenomena, and/or creates advances with high potential for significant industrial and environmental impact.

- **Thermal Systems and Engineering**—This program supports fundamental research in two major areas: heat transfer and energy systems, and combustion and thermal plasmas. Projects should be aimed at gaining a basic understanding at the microscopic and macroscopic levels of thermal phenomena underlying the production of energy, the synthesis and processing of materials, cooling and heating of equipment and biological systems and the interaction of industrial processes with the environment. Higher priority will be given to those projects which deal with problems on the cutting edge of technology while developing human resources in engineering

For More Information

Contact the Division of Chemical and Thermal Systems, National Science Foundation, Washington, D.C. 20550. (202) 357-9606.

Mechanical and Structural Systems

The objective of this division is to support research that will advance the engineering knowledge base necessary for developing new or improved mechanical and civil engineering technologies. Specific research directions are driven by intrinsic interest in phenomena arising in mechanical and structural systems and by the need to solve increasingly complex problems requiring consideration of systems, synthesis, and integration. Research methods include a blend of techniques involving mathematical and computer simulation, and physical experimentation.

Areas of Research

- **Dynamic Systems and Control**—This program supports research on the dynamic behavior and control of machines, processes, structures, vehicles, and other engineered physical systems. The primary emphasis is the physical modeling of dynamic systems of all types, to improve the knowledge base for analyzing their performance and aspects of their control. Research topics include dynamics theory, control of mechanical systems, acoustics and noise control, and machine dynamics. The major program support addresses significant gaps in or extends the knowledge base of these disciplines. A second category of research is high risk research that may lead to revolutionary advances in the field.

- **Materials Engineering and Tribology**—Research aimed at developing a strong science and technology base in materials engineering, materials processing, and tribology. Emphasis will be on engineered materials and surfaces for structural applications, novel processing and research techniques, and modeling, as well as on areas which have the potential to significantly impact the U.S. economy. Interdisciplinary activities and university-industry joint research are especially encouraged.

- **Solid and Geomechanics**—This program supports fundamental research to enhance the engineering and scientific understanding of the mechanical behavior and safety of structures, components and engineering materials including geomaterials and geologic structures. The program emphasizes basic research to improve the state-of-the-art of analytical, computational, and experimental methods in mechanics and addresses all classes of solids with elastic, inelastic, plastic, or viscous behavior.

- **Structures and Building Systems**—Research enhances the development of knowledge basic to the design and construction of safe, long-lived, maintenance-free, economical structures and facilities, and research basic to the design, construction, and efficient operation of structures and buildings. In addition, research in this program is directed toward understanding the science and technology of deterioration of constructed facilities and actions that can be taken to diagnose, repair, retrofit, and enhance the performance of existing constructed facilities and to incorporate the knowledge gained in improving the future performance of new constructed facilities and materials.

For More Information

Contact the Division of Mechanical and Structural Systems, National Science Foundation, Washington, D.C. 20550. (202) 357- 9542.

Electrical and Communications Systems

The Division of Electrical and Communications Systems supports research that enhances the engineering knowledge base for the analysis, synthesis, design, and fabrication of materials, devices, systems and phenomena that involve electrical, electronic electromechanical, or optical technologies.

Areas of Research

- **Quantum Electronics,Waves, and Beams**—Fundamental scientific and engineering research principally in areas of quantum electronics, including lightwave technology, plasmas, and electromagnetics. Theoretical and experimental research related to the generation, propagation, interaction, manipulation, and analysis of electromagnetic radiation and charged particles and to their technology implementation are appropriate to this program. Also included in the program: optoelectronic and photonic devices and systems, optical computing and storage, and optical communications research.

- **Communications and Computational Systems**—The program is comprised of three major components: Communications engineering, computational engineering, and neuroengineering. Communications engineering supports research for the design of ultra high speed/capacity optical communications and computing systems. Computational engineering provides an interface between engineering and applied mathematics and integrates computational power with analysis and experiments for engineering applications. Neuroengineering develops and tests algorithms which are capable of learning.

- **Engineering Systems**—Support of basic research in analytical and computational methods for modeling, optimization and control of natural and man-made systems. Research topics include new methodologies for the solution of engineering systems problems. The main focus points are automatic control systems and electric power systems. Projects supported by this program include a wide range of engineering constraints and environments.

- **Solid State and Microstructures**—Research in the fields of solid-state electronic devices and associated technologies, with an increasing emphasis on submicron and integrated optoelectronic devices. There is also a strong emphasis on the physics of device operation and advanced process techniques. The program serves as the focal point within NSF for interdisciplinary research in microstructure and microscience.

- **Emerging Technologies Initiation**—This program was created to establish an academic infrastructure to develop new engineering research areas between existing disciplines. The program assists in developing and testing new mechanisms on a small scale for the transfer of this knowledge to potential users, funding research, and training for researchers. Research is focused in selected areas of opportunity.

For More Information

Contact the Division of Electrical and Communications Systems, National Science Foundation, Washington, D.C. 20550. (202) 357-9618.

Design and Manufacturing Systems

The goal of this Division is to support research that seeks to serve a broad spectrum of American industry through developing and expanding the scientific and engineering foundations of design, manufacturing, production, and computer-integrated engineering. Long-term efforts are needed: to deepen our understanding of the processes, operations and systems which comprise modern manufacturing; and to make our manufacturing base more competitive by increasing its innovation and responsiveness to changing needs. Support of the development of operations research methodologies that underlie the full range of engineering systems for production complement these efforts.

Areas of Research

- **Design and Computer-integrated Engineering**—The program supports basic research in: (1) scientific theories of design, (2) foundations for design environments, and (3) models of design processes. Examples include computational models for the design process; languages and representations for design considerations such as function and form; design-oriented representations for preliminary and conceptual design, including multiple levels of abstraction and partial designs.

- **Manufacturing Processes and Equipment**—Development of an engineering science base for current and future physical manufacturing processes covering a wide range of raw materials (metals, polymers, ceramics, composites and specially engineered materials). Understanding of processing issues confronting the actual making of a product within the context of a complete design-production environment, as opposed to researching the processing characteristics of materials for their own sake.

- **Operations Research and Production Systems**—Basic research in analytic, computation and simulation methods for the analysis, modeling, design and optimization of natural and man-made systems. While research funded by this program is oriented toward basic methodologies, it is strongly motivated by engineering problems.

For More Information

Contact the Division of Design and Manufacturing Systems, National Science Foundation, Washington, D.C. 20550. (202) 357- 7508.

Biological and Critical Systems

This Division is divided into two sections: Bioengineering and Environmental Systems; and Hazard Mitigation.

The Bioengineering and Environmental Systems Section is concerned with expanding the knowledge base of bioengineering; in improving our ability to apply engineering principles to correct problems that impair the usefulness of land, air, and water; and in exploring basic engineering problems in the development, conservation, and use of ocean resources and systems.

The Hazard Mitigation Section seeks to develop a basic engineering understanding of potentially destructive natural phenomena such as earthquakes, floods, sea level rise, greenhouse effects, expanding and collapsing soils, destructive winds, landslides, tsunamis and storm surges.

Areas of Research

Bioengineering and Environmental Systems

- **Bioengineering and Aiding the Disabled**—Engineering research activities in this program, are conducted under three categories: biochemical engineering, biotechnology, and biomedical engineering and aiding the disabled.

- **Environmental and Ocean Systems**—Activities in this program are conducted under two categories: Environmental Systems; and Ocean Systems.

Hazard Mitigation Section

- **Earthquake Hazard Mitigation**—Engineering research activities in this program are conducted under four categories: siting and geotechnical systems; structural systems; architectural and mechanical systems; and earthquake systems integration. Basic science research in earthquake hazard mitigation is supported under the Earth Sciences Division in the Directorate for Geosciences (GEO).

- **Natural and Man-Made Hazard Mitigation**—This program supports research activities that strengthen the knowledge base on: (1) the physical phenomena underlying natural hazards such as floods, droughts, tornadoes, landslides, and (2) the understanding of their interactions with and the impacts on populations, structures, buildings and the natural environment.

For More Information

Contact the Division of Biological and Critical Systems, National Science Foundation, Washington, D.C. 20550. (202) 357-9545.

Engineering Centers

This division supports university research centers aimed specifically at enhancing our country's economic competitiveness by strengthening university/industry coupling in research and education. The division has three objectives:

- To establish cross-disciplinary research centers needed to improve the flow of fundamental engineering and scientific research between universities and industry.
- To strengthen the links between university research engineers and scientists and their industrial counterparts.
- To better prepare students in synthesizing, integrating and managing engineering and technological systems.

Programs

- **Engineering Research Centers—** The goal of this program is to develop advances in the knowledge and technical bases in areas enhancing the international competitiveness of U.S. industry by supporting major cross-disciplinary research and education centers at universities. ERCs are located at academic research institutions where they are expected to promote strong links between research and education.
- **Industry/University Cooperative Research Centers—**This program encourages highly-leveraged industry/university cooperation by focusing on fundamental research recommended by the Industrial Advisory Board. Each center is established to conduct research that is of interest to both industry and the university, with a provision that industry take over full support within five years.

For More Information

Contact Engineering Centers Division, National Science Foundation, Washington, D.C. 20550. (202) 357-9707.

Table 4—Engineering

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Biological & Critical Systems	$ 35.60	$ 36.13
Chemical & Thermal Systems	30.67	33.14
Electrical & Communications Systems	29.71	31.81
Mechanical & Structural Systems	22.70	24.41
Design & Manufacturing Systems	18.29	19.77
Engineering Centers	46.43	55.31
Engineering Infrastructure Development	16.82	25.43
Total	$200.22	$226.00

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).

5

GEOSCIENCES

Research in the geosciences is supported to advance the state of knowledge about the earth, including its atmosphere, continents, oceans, and interior, and the processes that modify them and link them together. General objectives of this research are to:

- Advance knowledge of the earth's upper and lower atmosphere, including its general circulation and the physical bases of climate, and the smaller-scale, shorter-term phenomena that describe weather processes.

- Provide further insights into the earth's structure, composition, processes, and history, and to improve understanding of its resources, hazards, and wise use.

- Improve knowledge of the physical, chemical, geological, and biological processes in the world's oceans, and at their boundaries with the atmosphere, the shoreline, the sea floor, and the earth's crust beneath.

- Foster, in the antarctic and arctic regions, multidisciplinary research that helps (1) to solve regional and worldwide problems and to protect the environment, and (2) ensure equitable and prudent use of resources.

Atmospheric Sciences

The Atmospheric Sciences program supports research to add new understanding of the behavior of the earth's atmosphere and its interactions with the sun. Included are:

- Studies of the physics, chemistry, and dynamics of the earth's upper and lower atmosphere.

- Research on climate processes and variations.

- Studies to understand the natural global cycles of gases and particles in the earth's atmosphere.

NSF also provides support to operate the National Center for Atmospheric Research (NCAR) and the Upper Atmospheric Facilities (UAF) program.

NCAR scientists conduct research in atmospheric and related sciences and work with universities and other organizations to coordinate large-scale atmospheric research projects. In addition, NCAR operates major aircraft, computer, and other facilities for use by university, NCAR, and other scientists.

The UAF consists of four large incoherent-scatter radar facilities located along a longitudinal chain from Greenland to Peru. They allow scientists to investigate both local and global upper atmospheric problems.

Finally, NSF provides support for participation by the U.S. scientific community in international scientific research endeavors, such as the World Climate Research Program.

ATMOSPHERIC SCIENCES PROJECT SUPPORT

The purpose of these programs is to continue to build a base of fundamental knowledge on the atmospheres of the earth and other planets, and of the sun. Specific objectives are:

- To develop the scientific basis for understanding (1) the dynamic and physical behavior of climate and weather on all scales, and (2) the natural global chemical cycles of gases and particles in the earth's atmosphere.

- To improve understanding of the composition, energetics, and particularly the dynamics of the coupled upper atmospheric system.

Examining cores from the ocean drilling program.

- To improve our knowledge of the sun as it relates to the earth's upper atmosphere and space environment.

Eligibility

Proposals may be submitted by academic institutions, nonacademic and nonprofit research organizations, profitmaking and private research organizations, and individuals. Occasionally, NSF sponsors efforts by other Government agencies, particularly for field programs.

Target Dates

Proposals may be submitted at any time during the year for all programs except for: those involving the allocation of observational and computing facilities and those proposals to the Climate Dynamics program.

Before submitting a proposal for facility support, institutions should seek advice from the Lower Atmospheric Facilities Manager at NSF. Contact Division Director, Scientific Computing Division, NCAR, for questions on computing proposals. Target dates for submission of facility and computing proposals are November 1 and May 1.

For the Climate Dynamics Program, target dates for proposal submission are May 1, August 1, and December 1. Review and processing of proposals normally takes six months.

For More Information

Contact the Division of Atmospheric Sciences, National Science Foundation, Washington, D.C. 20550.

Areas of Research

- **Aeronomy**—Upper and middle atmosphere phenomena of ionization, recombination, chemical reaction, photoemission, and transport; the transport of energy, momentum, and mass in the mesosphere-thermosphere-ionosphere system (includes the processes involved and the coupling of this global system to the stratosphere below and magnetosphere above); the plasma physics of phenomena manifested in the upper atmosphere-ionosphere system, including magnetospheric coupling efforts.

- **Atmospheric Chemistry**—The measurement and modeling of concentration and distribution of gases and aerosols in the lower and middle atmosphere; chemical reactions among atmospheric species; sources and sinks of important trace gases and aerosols; aqueous phase atmospheric chemistry; transport of gases and aerosols throughout the atmosphere; and improved methods for measuring the concentrations of trace species and their fluxes into and out of the atmosphere.

- **Climate Dynamics**—Supports research on processes that govern climate and the causes of climate variability and change; methods to predict climate variations and assess their impact on human activities; assembly and analysis of both paleoclimatic and modern climatic data; development and use of climate models to diagnose and simulate climate and its variations.

- **Large-scale Dynamic Meteorology**—Supports basic research to improve the understanding and prediction of atmospheric motion on synoptic to planetary scales. Research topics include the general circulation, synoptic scale weather phenomena, atmospheric predictability, and improved parameterization of physical processes and numerical methods for use in large-scale models.

- **Magnetospheric Physics**—Supports research into the magnetized plasma envelope of the outer atmosphere. As such, it is concerned with energization by the solar wind; the origin of geomagnetic storms and substorms; the population of the magnetosphere by solar and ionospheric sources; the origin of electric fields; the coupling between the magnetosphere, ionosphere, and atmosphere; and the waves and instabilities observed in this vast natural plasma laboratory. The observational programs tend to be located at high latitude and concern the aurora; the theory programs quite often include numerical simulations/modeling in order to tackle the complicated nonlinear, 3-dimensional plasma physics; and the data analysis includes gathering material from all sources, whether on the ground or on spacecraft-generated missions funded by defense, civilian, or foreign agencies.

- **Mesoscale Dynamic Meteorology**—Supports research on all aspects of mesoscale meteorological phenomena. Sponsored research includes studies of morphological, thermodynamic and kinematic structure of mesoscale systems; development of mesoscale systems and precipitation processes; energy transfer between scales.

- **Physical Meteorology**—Supports basic research devoted to the physics of the atmosphere with special emphasis on cloud physics, atmospheric electricity, radiation, boundary layer and turbulence, and the initiation, growth and propagation of gravity waves. The program also sponsors the development of new techniques and devices for atmospheric measurements.

- **Solar-Terrestrial**—Supports research into processes by which energy in diverse forms is generated by the sun, transported to earth, and ultimately deposited in the terrestrial environment. Major topics regarding the sun include helioseismology, the solar dynamo, the 11-year variation, magnetic flux emergence, solar flares and activity. Transportation of energy topics include coronal mass ejections, heating the solar wind, interactions of the solar wind with cosmic rays, and solar wind/magnetosphere boundary problems. In the atmosphere, relevant topics include photochemistry in response to UV changes, solar "constant" changes and climatic impacts, C14 and sun/climate connections, solar activity/climate variability and sun/weather variations on various time scales.

CENTERS AND FACILITIES

NSF plans the support for, and oversees the science programs and use of, the following facilities:

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR)

NSF supports the National Center for Atmospheric Research, a focal point for research in that field. Located in Boulder, Colorado, NCAR has about 650 scientists and support personnel.

NCAR is managed by the University Corporation for Atmospheric Research (UCAR), a nonprofit consortium of 57 North American universities with graduate programs in atmospheric sciences, under a cooperative agreement between the Foundation and UCAR.

NCAR facilities serve the entire atmospheric sciences research community and part of the ocean sciences community. The facilities available to university, NCAR, and other scientists include a computing center equipped with large mainframes, instrumented research aircraft, and ground-based Doppler radars. NCAR develops new or improved instruments for measuring the physical states of the atmosphere and oceans; these include advanced weather radars, remote automatic observing stations reporting to a central data collection point, upper-air observing systems, and buoys for ocean observations.

NCAR scientists conduct research in the atmospheric and ocean sciences and in solar astronomy, and they collaborate in large research programs involving many institutions. Research programs are selected for their scientific merit, potential for progress, appropriateness for a national center, responsiveness to and fit with university activities, and relevance to society's needs.

NCAR research programs include fundamental research in the following areas: large-scale atmospheric and ocean dynamics contributing to an understanding of past and present climate processes and global change including interactions with other environmental systems; global and regional atmospheric chemistry topics including geochemical and biogeochemical cycles; the variable nature of the sun and the physics of the corona; the physics of clouds, thunderstorms, precipitation formation and the interactions and effects on larger scale weather; and the examination of human society's impact on and response to global environmental change. In addition, NCAR provides fellowships for visiting scientists to conduct research and interact with NCAR scientists.

Eligibility

Facility and visiting scientist support is provided on a competitive basis to qualified scientists according to scientific merit, available facility time, and level of resources.

For More Information

Contact the Director, National Center for Atmospheric Research, P.O. Box 3000, Boulder, Colorado 80307.

UPPER ATMOSPHERIC FACILITIES (UAF)

NSF supports four large incoherent-scatter radar facilities located along a longitudinal chain from Greenland to Peru. In response to a need for more understanding of global-scale thermospheric and ionospheric problems, these facilities have been upgraded and realigned into a chain extending from the polar cap to the magnetic equator.

The major goal of the UAF program is to promote basic research on the structure and dynamics of the earth's upper atmosphere by:

1. Supporting the operation and scientific research of the incoherent-scatter radars and associated optical instruments which comprise the longitudinal chain.

2. Ensuring that these facilities are maintained as state-of-the-art research tools available to all interested and qualified scientists.

The UAF program supports the following:

- **The Sondrestrom Radar Facility** at Sondre Stromfjord, Greenland, which is operated by SRI International under an NSF cooperative agreement. This radar, which has been moved from Alaska, allows observations of the polar cap, the cusp (a region of easy access for solar wind energy), and the northern part of the auroral oval.

- **The Millstone Hill Radar** near Boston, Massachusetts, which is operated by MIT under an NSF cooperative agreement. It is located south of the auroral oval, in the region where significant mid-latitude phenomena are observed.

  Observations of high-altitude regions—from almost directly above the radar at Sondre Stromfjord to almost directly above the next radar in the chain at Arecibo, Puerto Rico—can be made there.

- **The Arecibo Observatory** at Arecibo, Puerto Rico, which is operated under contract to the NSF by the National Astronomy and Ionosphere Center of Cornell University. At Arecibo's latitude scientists have obtained evidence for particle precipitation into the atmosphere, composition changes in the atmosphere after magnetic storms, gravity waves propagating from the auroral region, and the penetration of magnetospheric electric fields.

  The UAF program also supports the high-frequency heating facility site near the Arecibo Observatory. This facility uses the ionosphere as a gigantic plasma physics laboratory, artificially injecting energy into the ionospheric medium to study plasma wave processes.

- **The Jicamarca Radio Observatory** at the magnetic equator in Jicamarca, Peru, is owned by the Instituto Geofisico de Peru. NSF is the principal sponsor of the facility via a cooperative agreement with Cornell University, which provides a subcontract to the Instituto.

- **The Incoherent-Scatter Database** at NCAR works to increase the effectiveness of the radar chain and enhance its scientific usefulness. The database receives data from the radars in the chain, making them available to all interested members of the scientific community.

Eligibility

UAF facilities are available on a competitive basis to all qualified scientists. Use is based on scientific merit of the proposed research, capabilities of the radars to carry out the proposed observations, and availability of the requested time.

For More Information

Contact the following:

Director, Sondrestrom Radar Facility, Radio Physics Laboratory, SRI International, Menlo Park, California 94025

Director, Millstone Hill Radar, MIT, Haystack Observatory, Westford, Massachusetts 01886

Director, NAIC (for Arecibo Observatory), Cornell University, Ithaca, New York 14853

Jicamarca Radio Observatory Project, Department of Electrical Engineering, Cornell University, Ithaca, New York 14853.

LOWER ATMOSPHERIC FACILITIES (LAF)

NSF supports the facilities at NCAR, university based instrumented research aircraft, and ground-based Doppler radar. These facilities are multi-user national research facilities and offer educational opportunities as well as serve the observational needs of the entire atmospheric science research community.

Eligibility

The Lower Atmospheric Facilities are available on a competitive basis to all qualified scientists. Use is based on scientific merit of the proposed research, capabilities of the facilities to carry out the proposed observations, and availability of the requested time.

For More Information

Contact the following:

Division Director, Atmospheric Technology Division, NCAR, P.O. Box 3000, Boulder, CO 80307-3000.

Department of Atmospheric Science, P.O. Box 3038, University Station, Laramie, Wyoming 82071.

Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, Rapid City, SD 57701.

Department of Atmospheric Sciences, Colorado State University, Fort Collins, CO 80523.

Earth Sciences

EARTH SCIENCES PROJECT SUPPORT

These programs provide funding support to U.S. colleges and universities and other non-profit institutions for the conduct of research and education in most areas of the solid-earth sciences. Emphasis is on the support of basic research aimed at an improved understanding of the earth's structure, properties, processes, and evolution, including basic research in areas of practical importance. This support is provided through grants, contracts, and cooperative agreements awarded in response to unsolicited, investigator-initiated proposals. The Foundation is a participant in the National Earthquake Hazard Reduction Program (NEHRP) and supports research under the Fundamental Earthquake Studies element of that program.

Support for projects in the Earth Sciences covers the full spectrum of topics in the subdisciplines of geology, geochemistry, geophysics, and paleobiology and is managed through four research programs. The programs are described below with a summary of the subdisciplines, methods, and techniques needed in the solution of the general problems; the scope of these descriptions should be viewed in the broadest terms. The subject matter of some proposals may overlap more than one program. In such cases appropriate program assignments will be made at the Division level and the proposal review will be coordinated among all relevant programs.

- **Geology and Paleontology**—This program supports studies of physical, chemical, geological, and biological processes at or near the earth's surface and the landforms, sediments, fossils, low-temperature fluids, and sedimentary rocks that they produce. Topics represented in the program include paleontology, paleoecology, stratigraphy, paleoclimatology, geomorphology, glacial geology, sedimentology, hydrogeology, soil genesis, sedimentary petrology, diagenesis, and organic geochemistry.

- **Tectonics**—The Tectonics program involves studies in structural geology, tectonics, geochronology, petrology, paleomagnetics, and other fields related to understanding the tectonic history of the lithosphere through time. Supported research includes field, laboratory, and theoretical studies of the processes and kinematics accompanying deformation at plate boundaries and in plate interiors.

- **Geophysics**—The Geophysics program supports laboratory, field, theoretical and computational studies related to composition, structure, and processes of the earth's interior. Topics include studies in seismicity and seismic wave propagation, the nature and occurrence of earthquakes, the earth's magnetic, gravity, and electrical fields, and its internal temperature distribution. Supported research also includes geophysical studies of active deformation, including GPS-based geodesy, and fundamental laboratory studies of properties and behavior of earth materials in support of geophysical observation and theory.

- **Petrology and Geochemistry**—The Petrology and Geochemistry program supports research on igneous, metamorphic, and hydrothermal processes that occur within the earth and other planetary bodies and on the minerals, rocks, fluids, and ore deposits resulting from these processes. Included are studies in mineralogy, crystallography, petrology, volcanology, geochemistry, economic geology, and meteoritics. Supported research includes field, laboratory, theoretical, and computational studies.

Eligibility

Proposals will be accepted from colleges, universities, and other institutions in the United States with formal research programs in the earth sciences.

Proposals may involve individual scientists or collaborative efforts of associated researchers working on coordinated projects.

Deadlines for receipt of proposals are June 1 and December 1 each year.

For More Information

Contact the Division of Earth Sciences, National Science Foundation, Washington, D.C. 20550.

CONTINENTAL DYNAMICS

This program supports multidisciplinary research that focuses on an improved understanding of the processes governing the origin, structure, composition and dynamical evolution of the continents and continental building blocks. The program is particularly oriented toward projects whose scope and complexity require a cooperative or multi-institutional approach and multi-year planning and execution. It is intended that the program would fund only relatively large projects which do not fit easily within Earth Sciences Project Support and which have broad support of major sections of the earth science community.

Eligibility

Proposals may be submitted by academic institutions and nonprofit research organizations.

Deadline

Preliminary proposals: December 1.
Formal proposals: June 1.

For More Information

Contact the Division of Earth Sciences, National Science Foundation, Washington, D.C. 20550.

INSTRUMENTATION AND FACILITIES

This program supports the acquisition or upgrade of equipment required for research, the development of new instrumentation and techniques that extend current research capabilities in the earth sciences, the operation of multiuser regional or national facilities that provide access to complex and expensive instrument systems for a significant segment of the earth science research community, and the support of research technicians.

Eligibility

Proposals may be submitted by academic institutions and nonprofit research organizations.

Deadlines for receipt of proposals are June 1 and December 1.

For More Information

Contact the Division of Earth Sciences, National Science Foundation, Washington, D.C. 20550.

Ocean Sciences

This division supports research to improve understanding of the ocean and ocean basins. Research programs support individual scientists, small groups of cooperating scientists, and some large coordinated projects. Ocean Sciences also supports efforts to develop, acquire, and operate the instrumentation and facilities needed to carry out these research programs.

OCEAN SCIENCES RESEARCH

These programs fund projects dealing with the disciplinary sciences of biological, geological, physical and chemical processes in the ocean. Grants are awarded on the basis of research and education merit, taking into account budgetary and programmatic reasons not directly related to research merit. In addition, there are frequent announcements of opportunity to participate in global change research programs.

The annual schedule of target dates for unsolicited proposals are November 1 and May 1.

More information on all divisional programs may be obtained by requesting a copy of "NSF Support of Ocean Sciences—An Informal Guide" (NSF 89-49). The target dates or deadlines for announcements of opportunity are listed in the quarterly Ocean Sciences Newsletter, which will be mailed to you on request (call Dr. Joan Mitchell, (202) 357-7912).

Proposals that require the use of UNOLS ships (see "Oceanographic Centers and Facilities" below) should be submitted by the November 1 target date so that timely decisions can be made on ship support and schedules. May 1 is the last target date field programs can be submitted for the following calendar year.

Areas of Research

- **Biological Oceanography**—Ocean productivity; distribution, abundance, physiology, and life history of pelagic, coastal, and deep sea marine organisms, and their interactions with environments; structures of pelagic and benthic food chains; primary and secondary production; interactions between deep sea biological processes and the ocean ecosystem; specialization of deep sea organisms; ecology of the Great Lakes and factors regulating productivity; marine biotechnology.

- **Chemical Oceanography**—Physical and chemical properties of seawater, including kinetic and thermodynamic equilibria of chemical species and compounds in seawater; fluxes between seafloor sediments, their interstitial waters, and overlying seawater; fates of materials deposited on the sea floor; alterations and interactions of material moving through the ocean; interactions and interdependencies between chemical processes and marine organisms; air-sea exchanges of man-made and naturally mobilized chemicals; chemical properties of the ocean surface.

- **Marine Geology and Geophysics—**Structure of continental margins, oceanic rise systems, and deep sea sedimentary basins; evolution of ocean basins; processes controlling exchanges of heat and chemical elements between seawater and oceanic rocks; tectonic and volcanic activity at mid-ocean ridges; chemical and mineralogic variations in marine sediments; deposition, erosion, and distribution of marine sediments; geologic and oceanographic processes controlling sedimentary systems; past oceanic circulation patterns and climates; evolution of microfossil groups; paleoenvironmental controls on fossil groups and sediment types; interactions of continental and oceanic geologic processes.

- **Physical Oceanography—**Description, analysis, and modeling of oceanic circulation and transport; effects of circulation on energy and momentum transport; physical circulation processes, eddy generation, and turbulent mixing on continental shelves; mixing processes and circulation in estuaries; wind-generated tides and surface and internal waves; small-scale transport processes such as diffusion, conduction and convection, and three-dimensional turbulence; physical properties of seawater; circulation and mixing processes in lakes.

OCEANOGRAPHIC CENTERS AND FACILITIES

The National Science Foundation supports construction, conversion, acquisition, and operation of major shared-use oceanographic facilities. The University-National Oceanographic Laboratory System (UNOLS) schedules these facilities and expeditionary programs.

This program supports expensive facilities necessary for NSF-funded research and training of oceanographers. Examples are ships, submersibles, large shipboard equipment, and complex instruments to collect and analyze data. Funds are also available to develop research instrumentation. However, the award of such funds does not imply continuing facility support.

The Foundation encourages local contributions from non-federal funds; however, there is no fixed requirement for institutional contributions.

Eligibility

Support for major oceanographic facilities is concentrated at a few institutions that have the capability to operate major ocean-science facilities. These institutions have substantial research programs in oceanography; they also support the research projects of other institutions.

Before submitting a proposal for support under this program, institutions should seek advice from the Oceanographic Centers and Facilities Section. Specific instructions on how to submit proposals for ship operations, technicians, shipboard equipment, and oceanographic instrumentation are available.

Deadlines and Target Dates

Proposals for ship operations and technicians are due October 1 each year. Proposals for shipboard equipment and oceanographic instrumentation are due September 1 each year. Target dates for instrumentation development proposals are May 1 and November 1 each year. Proposals requesting support for other activities may be submitted at any time.

For More Information

Contact the Division of Ocean Sciences, Oceanographic Centers and Facilities Section, National Science Foundation, Washington, D.C. 20550.

OCEAN DRILLING PROGRAM (ODP)

ODP activities are an international exploration of the earth's crust beneath the oceans to reveal the composition, structure, and history of the submerged portion of the earth's surface. Ocean drilling involves logging and collecting geologic samples from the floor of the deep ocean basins through rotary coring and hydraulic piston coring. The logs and samples of the cores are made available to qualified scientists throughout the world for research projects.

ODP Operations

The drilling program has sampled sites in the North Atlantic, Norwegian Sea, Mediterranean Sea, southern and equatorial Atlantic Ocean, Pacific Ocean off the west coast of South America, Weddell Sea off Antarctica, and in the western Indian and Pacific Oceans.

The general contractor for the overall management and operation of the ODP is Joint Oceanographic Institutions, Inc. (JOI), a consortium of major U.S. oceanographic institutions. Drilling operations are managed by Texas A&M University. Logging is managed by Lamont-Doherty Geological Observatory.

U.S. Science Support

Support for participation and drilling-related research performed by U.S. scientists is provided by NSF. This support focuses on the following:

- Investigations of potential drilling regions, especially by means of regional geophysical field studies.
- The feasibility and initial development of downhole instruments and techniques.
- Downhole geophysical and geochemical experiments.

In addition, NSF will consider proposals for studies leading to long-range definition of future drilling objectives.

To be considered for support, proposed projects should be clearly relevant to the drilling plans of the international drilling community and focus on predrilling or drilling concurrent activities. Postcruise studies should generally be submitted through other appropriate NSF programs such as Ocean Sciences, Earth Sciences, Polar Programs, etc.

Additional support for U.S. scientists may be obtained via the JOI U.S. Science Advisory Committee (USSAC). This NSF- sponsored program consists of the following elements:

- Planning activities, such as workshops, to define concepts and develop problem-related drilling programs, including U.S. participation in Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES).
- Support for U.S. scientists participating on the drillship and for necessary follow-up studies related to initial publication of drilling results.

In addition, requests for proposals (RFPs) may be issued for other surveys, regional and topical syntheses of existing data, and development of downhole tools and instrumentation as these tasks are identified.

For More Information

Contact the Ocean Drilling Program, Oceanographic Centers and Facilities Section, Division of Ocean Sciences, National Science Foundation, Washington, D.C. 20550.

Proposals for drilling specific sites should be submitted to JOIDES Planning Committee Chairman, c/o Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, N.W., Suite 800, Washington, D.C. 20036.

Applications for scientific participation aboard ship should be submitted to the Manager of Science Operations, Ocean Drilling Program, Texas A&M University, College Station, Texas 77843-3469. Appropriate support may be provided by JOI-USSAC.

Send requests for data and samples of core material to the Curator, Ocean Drilling Program, Texas A&M University, College Station, Texas 77843-3469.

Information regarding logs and the logging program may be obtained from the Borehole Research Group, Lamont-Doherty Geological Observatory, Palisades, N.Y. 10964.

Proposals for planning activities and workshops may be submitted to the JOI-USSAC Chairman c/o Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, N.W., Suite 800, Washington, D.C. 20036.

Polar Programs

U.S. ANTARCTIC RESEARCH

The U.S. Antarctic Research Program aims to increase understanding of the antarctic region and its relationship to the rest of the planet. This research is the major focus of the U.S. Antarctic Program, the comprehensive name for U.S. Government-sponsored activities in Antarctica. The Foundation funds and manages the U.S. Antarctic Program in support of the range of U.S. interests and the Nation's adherence to the Antarctic Treaty.

Research Objectives

The Foundation provides funding and operational support for basic research in the disciplines discussed below. Also, on occasion, applied research is supported, usually on a contract basis, to improve operational capabilities in Antarctica.

- **Astrophysics**—South Pole Station is well situated for long, continuous solar observations in summer, when the sun is above the horizon 24 hours a day. Astronomical observations also can be made during winter, when there is continuous darkness. The high elevation of the station (9,200 ft.), the dry atmosphere, the extremely low effective sky temperature, and long periods of clear weather provide superior observing conditions. The program objective is to encourage proposals for astrophysical projects at the South Pole.

- **Atmospheric Sciences**—Antarctica, the world's largest and most intense climate area, has an active relationship with regional and perhaps global weather and climate patterns. Far removed from pollution sources, it is an important monitoring and research area for world background levels of atmospheric constituents. Antarctica has proved a harbinger of natural and human-induced global atmospheric change. Research objectives are to improve understanding of physical processes of the atmosphere, to determine the relationship between events and conditions in the antarctic atmosphere and global events, and to determine the region's role in past and present global climate.

- **Earth Sciences**—Reconnaissance has identified the geology of most ice-free areas, and research has provided an outline of the region's geology and geophysics. Major clues have been obtained in support of the theories of continental drift and the Gondwanaland supercontinent. Geologic maps have been made of some areas. Objectives are to understand the geology and the geological history of the Antarctic and to determine the relationship of Antarctica to global geodynamics. A special objective is to collect and make available for study some of the large numbers of meteorites that have concentrated on the surface in ice ablation areas.

- **Glaciology**—The world's largest ice sheet covers 97 percent of the antarctic continent in thicknesses up to 4.8 kilometers. It is a storehouse of information about climate and atmospheric constituents and their variation over time. Objectives are to determine the dynamics of the ice sheets, to understand the climatic record stored in the layers of firn and ice, and to determine the present dynamic status of the ice sheets and their relationship to glacial and climatic history.

- **Marine Biology**—The oceans around Antarctica make up one of the world's most productive major regions. Objectives are to understand the structure and function of antarctic marine ecosystems, to determine the major features and adaptations of organisms, and to add to knowledge of their distribution, abundance, and dynamics. Major attention is on ship and shore-based studies stressing trophodynamics and including detailed investigations at all trophic levels. Emphases include krill, ice-edge ecosystems, and low-temperature adaptations.

- **Marine Geology and Geophysics**—The sea floor around Antarctica is complex and presents fundamental problems in marine geology and geophysics. Its sediments provide a detailed record of changes in the size of the antarctic ice sheet. Objectives are to interpret geological and glacial history as recorded in sediments and to support studies of specific scientific problems revealed by earlier surveys.

- **Medical Research**—Biomedical studies are directed toward epidemiology of viral infections and physiological and psychological attributes in small, isolated groups of people.

- **Physical and Chemical Oceanography**—The southern ocean has a central role in the world ocean. Large-scale heat exchange at the ocean surface overturns the water column and mixes trace constituents, making the southern ocean a major source of the world's intermediate and deep-water masses. Huge changes in the extent of sea ice (varying annually between 1 and 8 million square miles) also influence energy transfer. The Antarctic Circumpolar Current, the world's largest ocean current, has a major effect on general oceanic circulation. Research objectives are to determine the dynamics of formation and distribution of water masses, currents, and sea ice; to investigate the relationship between oceanic and atmospheric circulation systems and the physical basis for biological productivity; and to investigate the relationship of the southern ocean and climate.

- **Terrestrial Biology**—The meager biota of terrestrial Antarctica are of special interest, owing to adaptations to the extreme environment. The simplicity of these terrestrial ecosystems provides opportunities for analysis that is more difficult or impossible in the complex systems of the lower latitudes. Research objectives are to understand features and adaptations of organisms and to add to knowledge of their distribution, abundance, and dynamics.

- **Upper Atmosphere Physics**—Unique studies of the earth's magnetosphere and ionosphere and of sun-earth relationships are possible in Antarctica because of its physically stable location at high geomagnetic latitude. Year-round, station-based research is possible at geomagnetic latitudes ranging from 53 degrees south at Palmer to 79 degrees south at McMurdo Station. Research objectives are to improve understanding of the earth's upper atmosphere and near-space environment; to investigate coupling between the neutral atmosphere, the ionosphere, and the magnetosphere; and to investigate solar-terrestrial effects.

Operational Support

In addition to granting funds for research, the program provides scientists with logistics and operational support in the Antarctic. The support includes a year-round inland research station at the South Pole (90 degrees south latitude), two year-round coastal research stations (McMurdo at 78 degrees south and Palmer at 64 degrees south), summer camps as required for research, the ice-strengthened research ship Polar Duke, a fleet of LC-130 airplanes (ski-equipped C-130s), Twin Otter airplanes when required, UH-1N helicopters, an icebreaker for channel breaking, and a variety of oversnow vehicles. Ships of the U.S. academic fleet and the ocean drilling program also support research in the Antarctic on occasion. A 300-foot research ship with icebreaking capability is under construction for the U.S. Antarctic Program and will be available for research use in ice-infested areas of the southern ocean beginning in early 1992.

Air transport between New Zealand and McMurdo is provided several times per week in the austral summer from early October to the end of February. From McMurdo, the logistics hub, science parties in summer have access as required to other sites, including the station at the South Pole. Several flights are made in August between New Zealand and McMurdo, providing one opportunity each year for winter access to that station. Between February and October the summer camps are closed, and winter research is limited to the immediate environs of South Pole and McMurdo, where station residents are isolated as long as eight months.

Palmer Station, on Anvers Island by the Antarctic Peninsula, is logistically isolated from the rest of the U.S. Antarctic Program and relies mainly on the Polar Duke (during or between research cruises) for transport to a port at the southern tip of South America. The ship makes several trips throughout the year. Air access is possible a few times per year in summer in cooperation with the U.S. Air Force and Chile. Polar Duke provides onboard research support in marine biology, oceanography, and geophysics and can support science in other areas of the southern oceans.

Eligibility

U.S. academic institutions and academically related nonprofit organizations may submit proposals for research project support. Industry and local, state, and federal agencies are also eligible for support. The Foundation particularly encourages antarctic proposals from women and minorities, and encourages proposals for research projects that include participation by undergraduates and high school graduates under guidelines established by cross-disciplinary NSF programs (e.g., Research Experiences for Undergraduates and Young Scholars Program). All persons proposed to perform field work in Antarctica must pass a physical examination whose standards have been specified by the U.S. Antarctic Program.

Proposal Preparation

Obtain a proposal preparation kit from the Foundation's Division of Polar Programs (202-357-7817). This kit contains a brochure describing research opportunities and support capabilities of the U.S. Antarctic Program, forms on which support requirements are to be specified, and descriptions of legal requirements under the Antarctic Conservation Act. It also contains a copy of the Foundation's booklet, *Grants for Research in Education in Science and Engineering* (NSF 83-57), which provides instructions for preparing the science and budget portions of the proposal.

For scientists not familiar with the antarctic program, prior discussion with a Division of Polar Programs science program manager (202-357-7894) or, for operational questions, with a member of the Polar Operations Section (202-357-7808) can be helpful.

Deadlines

Requests for support of research in Antarctica must be received by June 1 of the year before the proposed start of field work. For example, proposals for the 1992-93 austral summer season and the 1993 austral winter must be received by June 1, 1991.

Field projects requiring large amounts of cargo in Antarctica may require additional lead time to allow for transport by ship.

Requests for support of antarctic research not involving work in the field should be received by June 1 preceding the fiscal year in which funds are sought. Thus proposals received by June 1, 1991 will be considered for funding beginning in fiscal 1992, which starts October 1, 1991.

Literature

Antarctic Journal of the United States (Est. 1966). Washington: National Science Foundation. Available from the Government Printing Office, Washington, D.C. 20402. Quarterly news plus annual reviews of U.S. Antarctic Research Program.

"Laboratory Antarctica: Research Contributions to Global Problems," by Gunter Weller and others. *Science,* December 4, 1987, pp. 1361-1368; January 22, 1988, p. 335.

The following publications are available from the Polar Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, D.C., 20037.

U.S. Research in Antarctica in the Year 2000 and Beyond (1986)

Antarctic Solid-Earth Sciences Research: A Guide for the Next Decade and Beyond (1986)

Recommendations for a U.S. Ice Coring Program (1986)

Polar Regions and Climate Change (1984)

Research Emphases for the U.S. Antarctic Program (1983)

Study of the Upper Atmosphere and Near-Earth Space in Polar Regions (1982)

Polar Biomedical Research (1982)

An Evaluation of Antarctic Marine Ecosystem Research (1981)

Physical Oceanography and Tracer Chemistry of the Southern Ocean (1988)

Data Coordination and Career Stimulation in Polar Biomedical Research (1988).

Other information: An ongoing *Antarctic Bibliography* prepared by the Library of Congress abstracts and indexes the world antarctic research literature published between 1951 and the present. Seventeen hardbound volumes and two cumulative indexes have been published to date. *Current Antarctic Literature* is a computer printout of abstracts issued monthly by the Library of Congress staff that produces the *Antarctic Bibliography*. It is available free to working scientists and librarians from the Division of Polar Programs.

The U.S. Geological Survey has reconnaissance maps of portions of Antarctica at various scales. An "Index to Topographic Maps—Antarctica" is available from the Distribution Branch, U.S. Geological Survey, Box 25286, Federal Center, Building 41, Denver, Colorado 80225.

A one-sheet map of the continent at 1:5,000,000 scale, published in 1970, is available from the Smithsonian Oceanographic Sorting Center, Washington, D.C. 20560.

Hydrographic charts of antarctic coastal and deep sea waters are available from the Defense Mapping Agency (DMA), Office of Distribution Services, Washington, D.C. 20315 (301-227-2495). An index is available.

Ice cores, ocean-bottom sedimentary cores, terrestrial sedimentary cores, dredged rocks, biological specimens, meteorites, and ocean-bottom photographs are available for study. Request "Specimen and Core-Sample Distribution Policy" from the Division of Polar Programs.

ARCTIC RESEARCH

This program coordinates and extends U.S. research under the Arctic Research and Policy Act of 1984 and directs the development, implementation, and coordination of national policies and research plans. NSF is the lead agency for such activities, and the NSF Director chairs the Interagency Arctic Research Policy Committee. The Director also is an ex-officio member of the Arctic Research Commission, appointed by the President pursuant to the Act.

The Foundation supports arctic research in two ways:

1. The Arctic Research Program, administered by the Division of Polar Programs, emphasizes projects requiring special support such as interdisciplinary and international projects. The disciplines supported in this program are discussed below.

2. Disciplinary research is supported by any other appropriate NSF division or program.

A prospective proposer should examine the *Guide to Programs* to determine which NSF office is most appropriate for the research envisioned. Two NSF brochures will provide additional assistance:

—*Grants for Arctic Research* (NSF 86-29), which describes NSF objectives for arctic research and lists selected NSF programs with potential interest in supporting arctic science and engineering.

—*Arctic Science, Engineering, and Education Awards: Fiscal Year 1989* (NSF 90-45), a list of all NSF arctic awards made in a recent one-year period.

The Foundation's interagency responsibilities assigned by the Arctic Research and Policy Act of 1984 have resulted in two additional publications that should interest arctic investigators:

United States Arctic Research Plan Biennial Revision 1990-91, available from the Division of Polar Programs, describes U.S. arctic research programs in the areas of Atmosphere and Oceans; Land, including Resources and Environmental Interactions; Health; and Social Sciences.

The journal, *Arctic Research of the United States*, available from the Division of Polar Programs, describes federal, state, local, and privately sponsored arctic research.

In the Arctic Research program, a goal is to foster research that contributes to understanding and solving arctic and global problems. Field projects outside the Arctic but directly related to arctic science and engineering also will be considered, as will related laboratory and theoretical studies. Specific areas of interest include the following:

- **Atmospheric Sciences**—In meteorology, stratus clouds, tropospheric chemistry, radiation balance, arctic lows, and arctic haze; past climates and atmospheric gases as preserved in snow and ice cores;

and sea-ice-air interactions. In upper atmosphere physics, magnetosphere-ionosphere coupling, the plasma-pause, and wave-particle interactions.

- **Biology**—Marine, freshwater, and terrestrial biology; ecology; ecosystem structure and processes; anthropology; the effect of human activities on the environment. Understanding of species, communities, and ecosystems. Process studies on nutrient cycling and land-atmosphere interactions, particularly in the context of regional and global changes.

- **Earth Sciences**—Physical and chemical processes at or near the earth's surface, paleomagnetism, stratigraphy, soil genesis, geologic hazards, heat flow, permafrost, seismology, tectonics, crustal structure, origin of the Arctic Basin, and paleoecological and paleoclimatic reconstructions and comparisons with modern environments.

- **Glaciology**—Past climates, atmospheric paleochemistry, ice stream dynamics, glacial geology and hydrology, and mass balance of ice sheets. Rapid movements of glaciers and ice streams, because of their potential for contributing to changes in sea level. Ice core analysis for paleoclimates and predicting future climates; ice coring.

- **Oceanography**—Structure of the Arctic Ocean and adjacent seas, their interactions with the rest of the hydrosphere, and their role in global climate. Formation, maintenance, and decay of sea ice. Magnetic anomalies, heat flow, sedimentary history, and gravitational values at the ocean floor. Relationships of chemical and physical processes with marine organisms and productivity.

- **Social Sciences**—A multidisciplinary program encompassing archaeology; cultural, social, and physical anthropology; ethnology; history; geography; sociology; psychology; linguistics; political science; law; economics; and related subjects. Research themes of particular concern are rapid social change, community viability, and human/environment interactions. Projects which are circumpolar are encouraged.

Of the many other NSF programs that have supported arctic research, the following has defined arctic objectives:

- **Engineering**—Properties of snow, ice, and frozen soils and hydrology in arctic and related cold environments; thermodynamic and transport phenomena, geomechanics; mitigation of natural and human-made hazards; evaluation of structures and building systems, ocean engineering.

Eligibility

Any U.S. scientist interested in doing research may initiate a proposal, which is submitted formally by his or her institution. The Foundation particularly encourages arctic proposals from women, minorities (including Native Americans), and persons with disabilities. NSF also encourages proposals for research projects that include participation by undergraduates and high school students under guidelines established by cross-disciplinary NSF programs (e.g., Research Experiences for Undergraduates and Research Assistance for Minority High School Students). Graduate students are not encouraged to initiate proposals but to participate as research assistants to principal investigators. Most successful proposals are submitted by U.S. universities and colleges. Nonprofit, nonacademic research institutions, private profit making organizations, and local and state governments also are eligible for support; foreign institutions rarely are. Under certain circumstances, unaffiliated scientists may be eligible for support. The Small Business Innovation Research program provides opportunities for science and technology firms with competence in polar science, engineering, and operations.

Special Proposal Requirements

Except for certain research in Greenland and at sea, the Foundation does not arrange for or provide logistics for arctic research; it is usually the responsibility of the proposers to arrange and budget for these items. The proposal must include sufficient information to assure safety and feasibility of the field work. It must identify all proposed field personnel and describe their qualifications for the work they are to do.

U.S.-sponsored research in Greenland requires prior notification to the Danish Commission for Scientific Research in Greenland, along with indemnification. Investigators contemplating Greenland research should request a copy of the Project Proposal/Data Sheet for U.S. Scientific Research in Greenland from the Division of Polar Programs.

Deadlines

The Division of Polar Programs has a September 1 deadline each year for its Arctic Research program. Proposals may be submitted as early as two months before the deadline. Most other programs supporting proposals for arctic research have no specific deadlines or have several target dates per year. Two target dates for arctic social sciences proposals have been established: August 1 and January 1. For research in Greenland, researchers should submit the Project Proposal/Data Sheet (described above) by October 1.

For More Information

Address communications to the Division of Polar Programs, National Science Foundation, Washington, D.C. 20550.

Other Polar Research Opportunities

See *Small Business Innovation Research* (NSF 90-31)— Advanced concepts in scientific or engineering areas, particularly where the research may serve as a base for technological innovation. Polar topics include frost action, geophysical and space technologies, biotechnology, and operations and construction.

Table 5a—Geosciences

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Atmospheric Sciences	$104.10	$120.12
Earth Sciences	60.11	71.53
Ocean Sciences	147.37	171.00
Arctic Research Program	12.45	16.65
Science and Technology Centers	0.98	4.43
Total	$325.01	$383.73

SOURCE: Fiscal Year 1991 Budget to Congress--Justification of Estimates of Appropriations (Quantitative Program Data Tables).

Table 5b—U.S. Antarctic Program

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
U.S. Antarctic Research Program	$ 17.02	$ 19.00
Operations Support	99.37	110.00
Major Construction and Procurement	35.29	46.00
Total	$151.68	$175.00

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates

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MATHEMATICAL AND PHYSICAL SCIENCES

NSF-supported research projects in this area aim to develop a fundamental understanding of the physical laws that govern the universe. Research results lay the groundwork for the technological developments upon which our economic and social well-being depends. In engineering and in the biological and behavioral sciences, results from mathematical and physical science research form much of the intellectual underpinning, providing, for example, many of the research instruments and techniques in those fields.

Projects supported range from basic to applied research. In addition, support may go to research workshops, symposia, conferences, the purchase of scientific equipment for research purposes, and construction of specialized research facilities.

To give reasonable assurance of long-term support for continuing projects of high scientific merit, funding may be provided for periods up to 60 months in annual increments (contingent upon the availability of the funds and satisfactory progress of the research). Most support is for periods of 24 to 36 months.

Before submitting a proposal for research support, consult the most recent revisions of the brochure, *Grants for Research and Education in Science and Engineering Research* (NSF 90-77), for guidance in preparing the application. The brochure shows a recommended format, but standard application forms are not required.

Eligibility

Scientists initiate research proposals, which are usually submitted on their behalf by their employing institutions. The Foundation welcomes proposals by organizations on behalf of all qualified scientists and engineers, and it especially encourages those initiated by female and minority researchers and persons with disabilities.

The most frequent recipients of support for basic scientific research projects are colleges, universities, and nonprofit research organizations. In special circumstances, as noted in the *Guide's* Introduction, grants are also made to other types of institutions and to individuals. In these cases, preliminary inquiry should be made to the appropriate program officer before a proposal is submitted.

Support may be provided for projects involving one or more scientists. Awards are made for projects in a single discipline and also for those that cross or merge disciplinary lines.

Deadlines

Submit proposals at any time. Allow at least six months for processing. Proposals to be funded in a particular fiscal year (ending September 30) normally should be received by NSF no later than December of that fiscal year.

For More Information

Contact the appropriate division director, National Science Foundation, Washington, D.C. 20550.

High voltage terminal for the light ion Cooler Ring at the Indiana University Cyclotron Facility.

Astronomical Sciences

Areas of Research

The overall objective of the Astronomical Sciences Program is to increase our knowledge of the universe. Research is aimed at determining the composition, structure, and evolution of planets, stars, and galaxies, including our sun and the Milky Way.

In addition to providing research grants, the National Science Foundation supports the development and operation of three National Astronomy Centers where radio, optical, infrared, and special telescopes are made available on a competitive basis to the scientific community. Resident staffs at the Centers give technical assistance to visiting scientists, conduct studies of their own, and develop advanced instrumentation. These Centers meet national needs for research in specific areas of science requiring facilities, equipment, staffing, and operational support that could not appropriately be offered to a single institution to the exclusion of others.

ASTRONOMY PROJECT SUPPORT

The Astronomy Project Support program provides a broad base of support for fundamental research aimed at an understanding of the states of matter and physical processes in the solar system, our Milky Way galaxy, and the larger universe.

Deadlines

Submit proposals at any time during the year; allow about six months for review and processing.

For More Information

Contact the Division of Astronomical Sciences, National Science Foundation, Washington, D.C. 20550.

Areas of Research

- **Astronomical Instrumentation and Development**—Development and construction of state-of-the-art detectors and data-handling equipment; procurement of detection and analysis systems for telescopes; development of interactive picture-processing systems; very-long-baseline interferometric instrumentation; and application of new technology and innovative techniques to astronomy.

- **Electromagnetic Spectrum Management**—Coordination with government agencies of electromagnetic spectrum use for research, as well as frequency assignments for other telecommunications/electronics systems.

- **Extragalactic Astronomy**—Theoretical and observational studies of extragalactic objects ranging from the nearest galaxies to the most distant quasars and their relevance to galactic evolution and cosmology.

- **Galactic Astronomy**—Theoretical and observational studies on the interstellar medium; and the structure and evolution of the Milky Way galaxy; the distribution and kinematics of stars in the galaxy; and the characteristics of star clusters, in the galaxy.

- **Solar System Astronomy**—Theoretical and observational studies of the detailed structure and composition of planetary surfaces, interiors, atmospheres, and satellites; the nature of small bodies (the asteroids, comets, and meteors); and the relevance of these to the origin and development of the solar system.

- **Stars and Stellar Evolution**—Theoretical and observational studies of the structure and activity of the sun; the physical properties of all types of stars; all aspects of stellar formation and evolution; the effects of mass loss, rotation, and magnetic fields; and the properties of stellar atoms and molecules of relevance to stellar astronomy.

NATIONAL ASTRONOMY AND IONOSPHERE CENTER

NSF supports the National Astronomy and Ionosphere Center (NAIC), a visitor-oriented National Research Center devoted to scientific investigations in radio and radar astronomy and atmospheric sciences. NAIC is operated and managed by Cornell University under contract to NSF. NAIC headquarters are in Ithaca, New York, and its principal observing facilities are 19 kilometers south of the city of Arecibo, Puerto Rico.

NAIC provides telescope users with a wide range of research and observing instrumentation, including receivers, transmitters, movable line feeds, and digital data acquisition and processing equipment. The Center has a permanent staff of scientists, engineers, and technicians who are available to help visiting investigators with their observing programs.

The principal research instrument is a 305-meter, fixed spherical radio/radar telescope—the world's largest single radio reflector. The frequency capabilities range from 50 megahertz to 5 gigahertz. Transmitters include an S-band (2,380-megahertz) radar system for planetary studies and a 430-megahertz radar system for aeronomy studies. A second observing site, located 9.6 kilometers from the main site, has a 30.5-meter steerable parabolic antenna; it is paired with the main antenna to provide an effective interferometric S-band radar mapping system. This antenna pair is also available for radio astronomy interferometry at a wavelength of 12 centimeters.

The S-Band Planetary Radar System is now available for high spatial resolution studies of stratospheric dynamics. A high-power ionospheric heating facility provides a unique capability to investigate nonlinear plasma phenomena in the ionosphere. The data-processing capabilities of the observatory include a Harris computer system and an array processor.

Eligibility

The NAIC facilities and instrumentation are available on a competitive basis to qualified scientists from all over the world. Telescope time is assigned after judgment of research proposals on the basis of scientific merit, the capability of the instruments to do the work, and the available telescope time.

For More Information

Contact the Director, National Astronomy and Ionosphere Center, Cornell University, Ithaca, New York 14853.

NATIONAL OPTICAL ASTRONOMY OBSERVATORIES

NSF supports the National Optical Astronomy Observatories (NOAO) as the national center for research in ground-based optical and infrared astronomy. Large optical telescopes, observing equipment, and research support services are made available to qualified scientists. As a scientific visitor-oriented facility, NOAO receives many U.S. astronomers and a smaller number from abroad. The NOAO resident staff of astronomers, engineers, and various support personnel is available to assist these visitors in meeting their scientific goals.

The headquarters of NOAO are in Tucson, Arizona. NOAO includes Kitt Peak National Observatory (KPNO), Cerro Tololo Inter-American Observatory (CTIO), and the National Solar Observatory (NSO). It is supported under a contract between NSF and the Association of Universities for Research in Astronomy, Inc. (AURA). A consortium of 20 major universities, AURA is responsible for operating and managing NOAO.

The observing facilities of KPNO are located on Kitt Peak, a 2,089-meter mountain 90 kilometers southwest of Tucson. This is the site of the 4-meter Mayall Telescope, a 2.1-meter general-purpose reflector with optimized infrared observing equipment, a 92-centimeter coudé feed (associated with the 2.1-meter), a 1.3-meter Cassegrain reflector for infrared observations and photometric studies, and a 91-centimeter auxiliary telescope available for solar, planetary, and bright-object observations. Solid-state array detectors, particularly of the charge-coupled-device types, are being applied to several faint-object observational problems.

CTIO provides qualified scientists with the telescopes and related facilities required for research in ground-based optical astronomy in the southern hemisphere.

CTIO has offices, laboratories, and housing for U.S.-hired staff in the coastal city of La Serena, Chile, about 482 kilometers north of Santiago on the Pan American Highway. Observing facilities are located on Cerro Tololo, a 2,194-meter mountain on the western slopes of the Andes, about 64 kilometers inland from La Serena.

CTIO operates seven telescopes, including the 4-meter near-twin to the Kitt Peak 4-meter instrument. The others are the 1.5-meter, 91-centimeter, 61-centimeter (originally installed by the Lowell Observatory for planetary observations), and 41-centimeter reflectors; a 61/81-centimeter Schmidt telescope on loan from the University of Michigan; and a 1-meter reflector on loan from Yale University. These instruments are equipped with spectrographs, cameras, and photometers similar to the ones at Kitt Peak.

The NSO is devoted to optical research in the fields of solar physics, solar-terrestrial relationships, and related areas. NSO makes available to qualified scientists the world's largest collection of modern optical solar telescopes and auxiliary instrumentation designed to observe the solar photosphere, chromosphere, and corona.

NSO has observing facilities atop Kitt Peak, Arizona, and Sacramento Peak, New Mexico. The Kitt Peak facilities consist of the 1.5-meter McMath Solar Telescope, the world's largest solar research instrument, and a solar vacuum telescope/magnetograph used for synthetic observations of the sun. Although the McMath telescope complex was designed primarily for solar observations, it is also used regularly for nighttime studies of planets and stars.

The Sacramento Peak observing facilities are located at an elevation of 2,800 meters on a crest of the Sacramento Mountains in south-central New Mexico, 59 kilometers east of Alamogordo.

The principal instruments are a 109-meter-high Solar Vacuum Tower telescope with an echelle spectrograph, digital diode array, and tunable filters, and an 8-meter spar in the Big Dome complex, equipped with a 40-centimeter aperture coronagraph, a magnetograph, and a polarimeter.

Other instrumentation includes a full complement of spectrographs, birefringent filters, and photographic, video, and digital data acquisition and processing equipment.

Eligibility

The NOAO facilities and instrumentation are available on a competitive basis to all qualified U.S. scientists and, on occasion, foreign visitors. Telescope time is assigned on the basis of scientific merit, the capability of the instruments to do the work, and the available telescope time.

For More Information

Contact the Director, National Optical Astronomy Observatories, P. O. Box 26732, Tucson, Arizona 85726.

NATIONAL RADIO ASTRONOMY OBSERVATORY

NSF supports the National Radio Astronomy Observatory (NRAO), which makes radio astronomy facilities available to qualified scientists. The NRAO staff helps visiting scientists use the large radio antennas, receivers, and other equipment needed to detect, measure, and identify radio waves from astronomical objects.

Headquarters for NRAO are in Charlottesville, Virginia. The three observing sites are located in Green Bank, West Virginia; Kitt Peak near Tucson, Arizona; and a site 80 kilometers west of Socorro, New Mexico. NRAO is supported under the terms of a contract between NSF and Associated Universities, Inc. (AUI), a consortium of nine universities responsible for NRAO operation and management.

One telescope system is operated at the National Radio Quiet Zone site in Green Bank. It is a 43-meter aperture instrument, which permits the study of spectral lines at centimeter wavelengths. The telescope is an integral part of the Very-Long-Baseline-Interferometer network; this network is involved in studies of quasars and the high-resolution mapping of galactic objects over transcontinental and intercontinental distances.

A 12-meter millimeter-wavelength telescope is located on Kitt Peak to take advantage of the high altitude and dry climate necessary for short radio wavelengths. This telescope is capable of both continuum and spectral-line studies at wavelengths from 1 centimeter to as short as 1 millimeter.

The Very Large Array (VLA) west of Socorro, New Mexico, consists of 27 antennas, available for use in an interferometric mode for aperture synthesis observations of faint radio sources. Both continuum and spectral-line observations at wavelengths of 1.3, 2, 6, and 20 centimeters can be made.

The four-element interferometer at Green Bank is operated full time for the U.S. Naval Observatory on a program of measuring the earth's rotation and determining certain astronomical constants.

Eligibility

NRAO makes observing time on each instrument available for the use of all qualified U.S. scientists and, on occasion, foreign visitors. Telescope time is assigned after judgment of research proposals on the basis of scientific merit, the capability of the instruments to do the work, and the available telescope time.

For More Information

Contact the Director, National Radio Astronomy Observatory, Edgemont Road, Charlottesville, Virginia 22903.

Mathematical Sciences

The Division of Mathematical Sciences supports a wide range of projects aimed at developing and exploring the properties and applications of mathematical structures. Most of these projects represent the research programs of single investigators or small groups of investigators working with graduate students and postdoctoral researchers. The range of these activities is described under the disciplinary program headings below. The Office of Special Projects handles a variety of different activities falling outside this mode.

Two activities that cut across all disciplinary programs deserve some explicit mention.

- **Mathematical Sciences Research Groups**—Mathematics thrives on the sharing of ideas among researchers. There has been a trend in recent years for significant work in the most active areas of the subject to emerge from groups of investigators organized around a common problem agenda or intellectual theme. The advantages of pooled insight and awareness make the successful research group more than the sum of its members. This is particularly important in research that requires input across the traditional subdisciplinary boundaries within the mathematical sciences or that cuts across major scientific disciplines.

Although individual efforts continue to be the core of the mathematics research enterprise, it is appropriate to recognize organized groups as a viable complement. Enhancing the effectiveness of these groups where they exist, and encouraging their formation where they are nascent, is part of the overall Division mission of fostering the mathematical sciences enterprise.

Mathematical Sciences Research Groups provide support for collaborative, multi-investigator research in all programs within the purview of the Division of Mathematical Sciences, across such programs, and jointly with other programs in the Foundation or at other Federal agencies. Group activity should envision work well beyond what could be accomplished by investigators working individually during a comparable time period. Within each program, a small number of awards will be made that reflect the coalescing of research activity into this collaborative mode.

- **Modern Geometric Mathematics**—There has been a rapid expansion of the role of geometric ideas throughout mathematics and its applications. Expanded support for incorporating these new ideas in all areas of the mathematical sciences will be provided through all disciplinary programs. Particular attention will be paid to the critical need for increased training at all levels to support the integration of deep knowledge of geometry with that of other fields.

For More Information

Contact the Division of Mathematical Sciences, National Science Foundation, Washington, D.C. 20550. (202) 357-9669.

- **Algebra and Number Theory**—Algebra, including algebraic structures, general algebra and linear algebra; number theory, including algebraic and analytic number theory, quadratic forms and automorphic forms; combinatorics and graph theory, and algebraic geometry.

- **Applied Mathematics**—Mathematical research motivated by and/or having impact on applied problems arising in science and engineering. Areas of interest include, but are not limited to, mathematics of fluid dynamics, solid mechanics, reaction-diffusion, and wave propagation; asymptotic methods; numerical analysis; variational methods; control theory; optimization theory; inverse problems; mathematics of biological sciences; mathematical physics.

- **Classical Analysis**—Properties and behavior of solutions of ordinary and partial differential equations; approximations and special functions; analysis of several complex variables, singular integrals, Hardy spaces and BMO; Kleinian groups and functions of one complex variable; and real analysis.

- **Computational Mathematics**—Computation is increasingly important to all sciences. Mathematics plays a unique role in providing the development of basic algorithms and techniques necessary to carry out computations. Proposals from interdisciplinary teams of mathematical, computer, and general scientists are encouraged in an effort to develop critical computational techniques from algorithm development through implementation. Proposals for innovative computational methods within the mathematical sciences are also encouraged.

- **Geometric Analysis**—Differential geometry and its relation to partial differential equations, global analysis, analysis on manifolds, several complex variables and Lie representation theory; geometric aspects of mathematical physics and dynamical systems; convex sets, integral geometry and related geometric topics.

- **Modern Analysis**—Research areas currently supported include Banach spaces; Banach algebras and function algebras; Lie groups and their representations; harmonic analysis; ergodic theory and dynamical systems; some aspects of mathematical physics (e.g., Schroedinger operators, quantum field theory); operators and algebras of operators on Hilbert space.

- **Statistics and Probability**—Statistics designs scientific methods to understand and analyze data. Major subfields include parametric and nonparametric inference, sequential analysis, multivariate analysis, Bayesian analysis, experimental design, resampling methods and robust statistics. Almost all these subfields have become computationally intensive in recent times.

  Probability theory is the study of mathematical structures that provide tractable models to statistics as well as many diverse areas such as physics, chemistry, biology and engineering. Major subfields include stochastic processes, limit theory, infinite particle systems, stochastic analysis in Banach spaces, martingales and Markov processes.

- **Topology and Foundations**—Algebraic topology, including homotopy theory, ordinary and extraordinary homology and cohomology, cobordism theory and K-theory; topological manifolds and cell-complexes, fiberings, knots and links; differential topology and actions of groups of transformations; general topology and continua theory; mathematical logic, including proof theory, recursion theory, and model theory, foundations of set theory and infinite combinatorics.

- **Office of Special Projects**—Modes of support different from the usual research project, including working research sessions (conferences, symposia, colloquia, special years, etc.) for which proposals should be submitted at least 12 months in advance, research institutes, and the following:

1. **Regional Conferences Operated by the Conference Board of the Mathematical Sciences**—These conferences feature a principal speaker who gives 10 one-hour talks on a subject during a week-long session. Deadline: April 1, 1991.

2. **Scientific Computing Research Environments in the Mathematical Sciences**—Moderate grants for computing equipment benefit groups of researchers of outstanding quality and high productivity whose work has been seriously impeded by the lack of computing facilities. Deadline: First Monday in December.

3. **Undergraduate Activities**—Awards are made in conjunction with NSF-wide undergraduate efforts. Activities include Research Experiences for Undergraduates, Instrumentation and Laboratory Improvement, Curriculum Development in Calculus, and related items. See later chapter for more on NSF's undergraduate efforts.

4. **Mathematical Sciences Postdoctoral Research Fellowships**—These go to approximately 30 new fellows each year. Tenure provides a research instructorship option. The fellowships will be offered only to persons who (1) are citizens or nationals of the United States* as of January 1, 1991; (2) will have earned by the beginning of their fellowship tenure a doctoral degree in one of the mathematical sciences listed above or have had research training and experience equivalent to that represented by a Ph.D. degree in one of those fields; (3) will have held the doctorate for no more than five years as of January 1, 1991; and (4) will not previously have held any other NSF postdoctoral fellowship.

Each applicant will be required to submit a research plan for the tenure period requested. The fellowships are not designed to support the preparation of prior research results for publication or the writing of textbooks.

Deadline for submitting applications is November 15, 1990.

For More Information

Contact the Program Director for Office of Special Projects, Mathematical Sciences Division, National Science Foundation, Washington, D.C. 20550. (202) 357-3453.

Physics

- **Atomic, Molecular, and Optical Physics**—(1) Electronic structure of isolated neutral and ionized atoms and molecules, their interparticle collision dynamics, and their interactions with charged particles and with electromagnetic radiation; and (2) the collective behavior of atoms, molecules, and their ionization products, in general and collisionless plasma environments. Specific current interests include: the non-linear response of isolated atoms to intense electromagnetic fields; the structure of "exotic" atoms; and ultraprecise tests of basis atomic properties and the laws of quantum electrodynamics using well-characterized electromagnetic fields.

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*The term "national of the United States" designates a citizen of the United States or a native resident of a possession of the United States (such as American Samoa). It does not refer to a citizen of another country who has applied for U.S. citizenship.

- **Elementary Particle Physics**—Properties and interactions of elementary particles; the experimental explanation of the most fundamental building blocks of matter, including quarks and leptons and the investigation of the interactions among elementary constituents. Research involves the use of high-energy beams from large accelerators or cosmic rays. Support goes primarily to university groups to conduct research at major accelerator laboratories world-wide or to specialized university-based facilities.

- **Gravitational Physics**—Theory of strong gravitational fields and applications to astrophysics and cosmology; fine details of weak gravitational fields; gravitational radiation; gravitational interaction with quantum mechanical systems.

- **Intermediate Energy Nuclear Physics**—Dynamics of nucleon and nuclear excitations and nuclear reactions, studied with primary and secondary beams from accelerators with energies in the 100 MeV to multi-GeV range; roles of mesonic and quark degrees of freedom in nuclei; basic interactions and fundamental symmetries investigated at the interface between particle and nuclear physics. The program supports a national light-ion cyclotron facility and university user groups executing experiments at a large number of laboratories in the U.S. and abroad.

- **Nuclear Physics**—Properties of nuclei and nuclear matter under extreme conditions, studied with heavy ions from low to ultra-relativistic energies; and the structure and dynamics of nuclei and nuclear excitations, studied with light and heavy ions and with neutrons. Universal symmetries and conservation laws are probed. Accelerator physics, interdisciplinary efforts, and applications to other fields are additional important components. The program supports university groups and a national heavy-ion facility.

- **Theoretical Physics**—Development of qualitative and quantitative understanding of fundamental physical systems ranging from the most elementary constituents of matter through nuclei and atoms to astrophysical objects. This includes formulating new approaches for theoretical, computational and experimental research which explore fundamental laws of physics and the behavior of physical systems; formulating quantitative hypotheses, exploring and analyzing the implications of such hypotheses computationally, and in some cases interpreting the results of experiments. The program supports research in elementary particle physics, nuclear physics, atomic and molecular physics, astrophysics and cosmology, mathematical physics, computational physics, non-linear dynamics, chaos, statistical physics and plasma physics, and it includes a considerable number of interdisciplinary grants.

- **Cross-Disciplinary Programs**—The Physics Division also supports activities in conjunction with Foundation-wide programs, such as Undergraduate Course and Curriculum Development, Instrumentation and Laboratory Improvement, Research Experiences for Undergraduates, and those programs that are aimed at women and under-represented minorities (see Chapters 3, 7, and 8). In addition, the division supports activities that improve the education and training of physics students (both undergraduate and graduate) and that are in general not included in specific programs elsewhere in the Foundation. This includes, for example, curriculum development for upper-level physics courses.

Chemistry

- **Analytical and Surface Chemistry**—Fundamental chemical research directed toward the characterization and analysis of all forms of matter. This program includes studies of elemental and molecular macrocomposition, and of microstructure of both bulk and surface domains. Investigations designed to probe the interphase region between different forms of matter are the responsibility of this program.

- **Chemical Instrumentation**—Supports acquisition, operation, and maintenance of the major equipment items required for advances in all fields of chemistry by university chemistry departments. Proposals are submitted by chemistry departments or departmental subunits for state-of-the-art electronic, magnetic, spectroscopic, or computational equipment for shared use within the university. Grants from this program require significant university and/or other-agency contributions to the purchase cost of instruments.

- **Inorganic, Bioinorganic, and Organometallic Chemistry**—The synthesis, structure, and reaction mechanisms of molecules containing metals, metalloids, and nonmetals, encompassing the entire periodic table of the elements. Included are studies of stoichiometric and homogeneous catalytic chemical reactions; bioinorganic and organometallic reagents and reactions; and the synthesis of new inorganic substances with predictable chemical, physical, and biological properties. Such research provides the basis for understanding the function of metal ions in biological systems, the synthesis of new inorganic materials and new industrial catalysts, and for systematic understanding of the chemistry of most of the elements.

- **Organic Chemical Dynamics**—The structures and reaction dynamics of carbon-based molecules, metallo-organic systems, and organized molecular assemblies. Research includes studies of reactivity, reaction mechanisms, and reactive intermediates; and characterization and investigation of new organic materials. Such research provides the basis for understanding and modeling biological processes, and for developing new or improved theories relating chemical structures and properties.

- **Organic Synthesis**—The synthesis of carbon-based molecules, metallo-organic systems, and organized molecular assemblies. Research includes development of new reagents and techniques for organic synthesis and characterization and for investigation of new organic materials and natural products. Such research provides the basis for designed synthesis of new materials and natural products, and for preparation of compounds important to the chemical and pharmaceutical industries.

- **Experimental Physical Chemistry**—Experimental investigations of the physical properties of chemical systems. Scientific issues range from the nature and properties of individual molecules to the behavior of molecules in the aggregate. Areas of current activity include spectroscopy of molecules and clusters of molecules; the elastic and inelastic scattering of molecules and photons; the thermodynamics and statistical mechanics of fluids and fluid mixtures; and the kinetics of chemical reactions.

- **Theoretical and Computational Chemistry**—Developments of chemical theory including quantum mechanics, statistical mechanics, and dynamics. Applications to all areas of chemistry, including support of computer code development.

- **Special Projects Office**—Management of the Chemistry of Life Processes and Materials Chemistry initiatives for the Chemistry Division. The office also provides support for collaborative projects in several other areas, including activities at the chemistry-chemical engineering interface, development of modern chemical instrumentation, and high-risk innovative projects that are critical to the field of chemistry but outside the normal responsibilities of the Chemistry Division programs. This office also coordinates review of proposals for Postdoctoral Fellowships and Research Experiences for Undergraduates. (See chapters 3 & 8.)

Materials Research

- **Metals, Ceramics and Electronic Materials**—The program focusses on fundamental research in these areas, but also includes the required theoretical and computational research support. The objective is to increase knowledge and predictive capabilities related to the effects of chemistry, processing, and microstructure on the properties and performance of these materials, as well as to expand understanding of the influence of the environment to which these materials are exposed.

Research in the Metals component encompasses the broad areas of physical and mechanical metallurgy. Topics currently supported include: phase transformations; thermodynamics and phase equilibria; microstructural characterization and morphology; fundamentals of solidification; nonequilibrium and amorphous materials; surface structure and properties; interface and grain boundary structure; corrosion and oxidation; defects; deformation and fracture of metals, polymers, and composite materials; and materials processing.

The Ceramics subelement includes research on the following topics: solid-state processing; organic precursors for ceramics; plasma processing; powder processing; ion implantation; novel analytical characterization techniques; advanced characterization of structure/microstructure; mechanical behavior of ceramics and ceramic composites; computational modeling of mechanical behavior; behavior under complex stress states and extreme environments; chemical stability, reactivity and kinetics; defect structures; and transport properties.

Examples of research in the Electronic Materials component include: electronic, magnetic, dielectric, and optical behavior of inorganic and organic materials, semiconductors, superconductors, insulators, and non linear optical materials; synthesis and processing of thin films, heteroepitaxial layers, nanostructures, and super lattice structures; novel processing routes and precursors; computational modeling of advanced processing techniques; and characterization of electronic and optical behavior of defects and defect arrays.

- **Materials Theory**—In this program, theoretical investigations of condensed matter physics and advanced materials to include structure, electronic properties and phenomenology associated with solid state physics and chemistry, metals, semiconductors, ceramics, polymers, liquids, quantum fluids, and other condensed phases of matter are carried out. Rigorous theory, modeling and numerical simulation are used to understand phenomena from the microscopic to microstructural/mesoscopic levels.

Topics of interest include surface and interfacial phenomena; systems far from equilibrium; phase transitions and critical phenomena; superconductivity and superfluidity; nonlinear and dynamical phenomena; growth and epitaxy; predictive capabilities for structure-property relationships; lattice dynamics; defects and their interactions; elementary excitations and their interactions; electronic, optical and magnetic properties; and kinetics and transport phenomena.

- **Condensed Matter Physics**—The objectives of this program include understanding the basic physical behavior of solids and other forms of condensed matter. Experimental research on metals, semiconductors, and insulators in the crystalline state, the amorphous state, and various other states of disorder. Phenomena to be studied include phase transitions; electronic, magnetic, and lattice structure of solids; elementary excitations (e.g., electronic, spin, plasma, and lattice excitations); transport and optical properties of condensed matter, and non-linear dynamics.

Particular areas of activity include the study of surfaces, thin films, superconductivity, superfluid properties of helium, interfaces, microstructures, and phenomena as they pertain to systems of reduced dimensionality and reduced crystalline perfection. Also included are amorphous and disordered solids, liquid crystals, and nonequilibrium systems. The development of new experimental techniques and other types of instrumentation is an important part of this activity. Synthesis, characterization, and analysis of new materials are also of interest. In addition, support will include experimental research on condensed matter that requires extreme conditions such as low or ultra-low temperatures; ultra high pressures, and high magnetic fields.

- **Special Programs in Materials Office**—This office provides support for major interdisciplinary Materials Research Laboratories designed to complement individual research funding by undertaking programs of a scope or complexity not normally feasible under traditional support. Essential activities include the development and operation of central experimental facilities for the joint use of faculty and students, major cooperative research programs in important materials problems or problem areas, and seeding of novel concepts and ideas in materials research. The office also provides support for collaborative, multi-investigator Materials Research Groups. These groups address major problems in materials research that require the combined expertise of several investigators and requisite instrumentation. Support for such group research is expected to be three to five times larger than that provided in individual grants.

Several of the Division's cross-directorate activities are handled through this office including Small Business Innovation Research, Presidential Young Investigator Awards, Instrumentation and Laboratory Improvement, Research Experiences for Undergraduates, Research Opportunities for Women, Research in Undergraduates Institutions, and Minority Research Initiation programs.

Finally, the office is responsible for the management and coordination of new programs and initiatives in emerging areas of materials research, such as the existing Materials Chemistry and Chemical Processing cross-directorate initiative and the presently contemplated initiative in the area of biomolecular materials.

- **Solid State Chemistry and Polymers**—The program emphasizes synthesis, characterization, and structure-property relationships of materials at a molecular level, with special attention to new materials or materials with superior properties.

The solid-state chemistry component supports research in the following areas: innovative synthetic routes to new inorganic and organic solid-state and mesophase materials; characterization of new materials with interesting electronic, optical, magnetic, and chemical behavior; relationships between bulk, surface, interface, and defect structures, and properties such as chemisorption, transport, and reactivity; and materials preparation, processing, and optimization by chemical means.

The polymers component deals with research on the fundamental physical and chemical behavior of synthetic macromolecules and the complexities resulting from their large size; synthesis of new polymers of high molecular weight and precisely defined structure, as well as unconventional methods of polymerization; characterization of the chemical and physical structure of polymers by state-of-the-art instrumental techniques; molecular arrangements in amorphous, crystalline, and liquid-crystalline polymers and in their mixtures; compatibility and phase relations in polymer blends; macromolecular chain dynamics and relaxations; molecular characteristics and their relations to solution, surface, electro-optical, and other properties; fundamental polymer and surface science of organic-matrix composites.

- **National Facilities and Instrumentation**—Research facilities and specialized instrumentation available on a national scale to the research community in general and the materials research community in particular. These facilities provide unique research capabilities that can be located only at one or a very few laboratories in the nation. Examples include facilities and resources for research using high magnetic fields, ultraviolet and X-ray synchrotron radiation, small-angle neutron scattering, and ultrahigh resolution electron microscopy. Support is also provided for multiuser, multidisciplinary instrumentation; instrument and technique development; major equipment that normally would be handled by a single program but costs more than

$200,000; and closed-cycle helium liquefaction systems.

For more information on the National Facilities, contact the facilities as follows:

Cornell High-Energy Synchrotron Source
Wilson Laboratory
Cornell University
Ithaca, New York 14853
(607) 255-7163

Wisconsin Synchrotron Radiation Center
University of Wisconsin-Madison
3731 Schneider Drive
Stoughton, Wisconsin 53589
(608) 873-6651

Center for High Resolution Neutron Scattering
National Institute of Standards and Technology
Reactor Radiation Division
Gaithersburg, Maryland 20899
(301) 975-6228
(Expected to be open to users March 1991)

Francis Bitter National Magnet Laboratory
Massachusetts Institute of Technology
170 Albany Street
Cambridge, Massachusetts 02139
(615) 253-1557

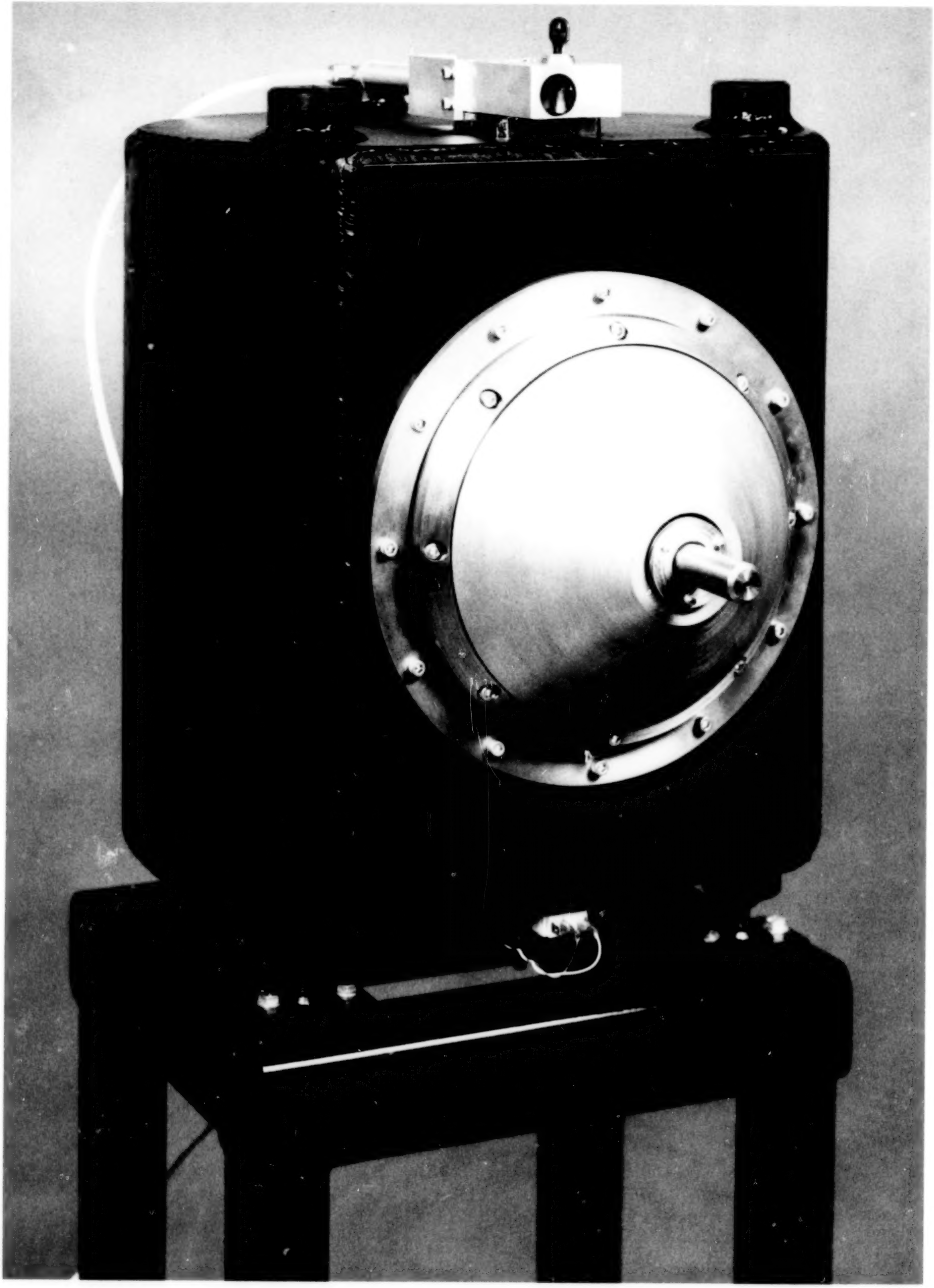
Regional Center for High-Resolution Electron Microscopy
Center for Solid-State Science
Arizona State University
Tempe, Arizona 85287
(602) 965-6459

Table 6—Mathematical and Physical Sciences

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Mathematical Sciences	$ 69.12	$ 73.72
Astronomical Sciences	91.65	100.70
Physics	123.83	130.23
Chemistry	97.94	103.35
Materials Research	116.94	123.46
Science and Technology Centers	14.54	27.04
Major Research Equipment	42.99	63.00
Total	$557.01	$621.50

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).



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SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS

This category of programs combines NSF activities designed to:

1. Advance U.S. economic competitiveness by promoting healthy international relationships and enhancing the work of U.S. researchers through cooperative activities with foreign scientists and institutions.

2. Study science and technology policy issues, and provide information and analysis for public policies designed to improve the Nation's scientific enterprise and its service to society.

3. Collect, analyze, and publish data on the status of the Nation's science and engineering resources.

4. Provide opportunities for small high-technology firms to participate in NSF-supported research.

5. Extend greater research opportunities to states that have traditionally been less competitive in obtaining federal research and development support.

6. Transfer technology through a three phase grant program supporting academic/industry research and technology with high commercial potential.

The Experimental Program to Stimulate Competitive Research (EPSCoR) brings research endeavors at academic institutions within participant states to nationally competitive levels, increases institutional science and engineering research capability, and improves overall state R&D competitiveness.

Programs for Industrial Science and Technological Innovation provide opportunities for small business innovation research, cooperative work between universities and industry, and cooperative efforts involving scientists, engineers, and the general public.

International Cooperative Science and Engineering Activities support joint efforts with advanced and developing countries.

Science Resources Studies provide research, analysis, and reports on the overall scientific and technological enterprise and its impact on society.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

The National Science Foundation's responsibility for developing and maintaining the health of science and engineering throughout the United States extends to states that have traditionally been less competitive in obtaining federal R&D support. Initiated in 1979, EPSCoR's basic premise is that academic research activity underpins a state's overall R&D competitiveness. Its goal, therefore, is to bring the science and engineering research endeavors at academic institutions within participant states to nationally competitive levels as part of a plan to increase their science and engineering

Radiation source used in tomography (equipment developed under Small Business Innovation Research program).

research capability and hence their overall R&D competitiveness. The program is currently operating in sixteen states (Alabama, Arkansas, Idaho, Kentucky, Louisiana, Maine, Mississippi, Montana, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming) and the Commonwealth of Puerto Rico. Adopting a pro-active role, the NSF has cooperated with state leaders in government, higher education, and business to establish productive long-term partnerships. In each state the NSF's role is catalytic in nature and is designed to stimulate local action that will result in permanent improvements to the state's research infrastructure and increased R&D competitiveness. Significant local cost sharing is a characteristic of the NSF/state partnership. Over EPSCoR's ten-year history, the NSF has invested approximately $52 million, while the States have provided over $156 million.

Industrial Science and Technological Innovation

The National Science Foundation has always been acutely aware of the relationships between industrial development, technological innovation, and scientific research. The Industrial Science and Technological Innovation Division supports programs which address these relationships in the form of the Small Business Innovation Research (SBIR) program and the College and University Innovation Research (CUIR) program. Under the requirements of the Small Business Innovation Development Act of 1987, P.L.99- 443, the NSF supports research conducted by small, high technology firms. Technology transfer of research with high commercial potential is to be implemented under the CUIR program through grants to academic institutions to form university/industry research partnerships.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

This program offers an opportunity and incentive for small, creative science- and technology-oriented firms. They may conduct innovative high-risk research on important scientific and technical problems—work that could have significant public benefit if the research is successful. The program meets the requirements of the Small Business Innovation Development Act of 1987 (P.L. 99-443).

This is a three-phase program that offers incentives for converting research done in phases I and II to commercial applications in phase III, with the last effort funded by private capital. Phase I awards, at a maximum of $50,000, are made to determine whether a research-based idea seems technically feasible and whether the proposing firm can do high-quality research. Phase II funds those research projects found most promising at the end of phase I; previous phase II awards have averaged $110,000 a year for up to two years. No NSF support is involved in phase III.

One objective of this program is to increase the return on investment to the public from federally funded research. A key part of this effort is to encourage a commitment for phase III financing by a third party before NSF funds phase II. The commitment is effective only if phase II achieves certain mutually agreed-upon technical objectives. Phase III financing introduces early private-sector funding and indirectly couples the NSF-supported research to outside evaluations of the potential market, management, and financial requirements.

Research topics may range from engineering and the physical sciences to the life sciences, with emphasis on advanced research concepts that could serve as a basis for technological innovation. The mix of topic areas will differ somewhat with each solicitation for proposals.

Eligibility

Eligibility is restricted to small business firms—those organized for profit, individually owned and operated, not dominant in the field in which they are bidding, and having an average of not more than 500 employees in all affiliated firms. In addition, the primary employment of the principal investigator must be with the small business firm at the time of award.

Deadlines

Annual solicitations made by this program are widely publicized by the Small Business Administration. They are also announced in the *Commerce Business Daily* and sent to those on NSF's small-business mailing list. Solicitations list specific deadlines for proposals.

For More Information

Request the latest *Small Business Innovation Research* solicitation brochure.

Contact the Program Manager, Small Business Innovation Research, National Science Foundation, Washington, D.C. 20550. (202) 357-7527.

COLLEGE AND UNIVERSITY INNOVATION RESEARCH PROGRAM

The College and University Innovation Research (CUIR) program—patterned after the SBIR program—supports phase I proposals for work at a college or university, and follows through with phase II research awards to competitively selected phase I awardees. Phase II research would be carried out in both the university and the private sector. Phase III comprises the private-sector sponsored development and commercialization effort.

Phase I addresses only the feasibility of a research concept. It is this phase which furnishes the data, in minimum time and cost, that determined whether a major applied research thrust should be initiated. The program provides for a flexible six-month to one-year term for phase I. Typical phase I grants are $50,000. During the phase I period, the academic researcher must select a private sector "partner" with whom to collaborate in later stages of the project.

This partner must participate in the phase II research to enchance the commercialization potential of the project. This "partnership" is an essential component of the knowledge and technology transfer process, as well as of economic development resulting from such university/industry coupling. The partnership concept constitutes a major departure of the CUIR approach from the SBIR model.

Eligibility

Proposals may be submitted by colleges, universities, and non-profit institutions. Colleges and universities may submit proposals on behalf of their faculty members. Non-profit institutions, such as independent museums, observatories, or research laboratories having special research capabilities, are also encouraged to submit proposals on behalf of members of their scientific or engineering staff.

Deadlines

Annual solicitations made by this program will be widely disseminated. Solicitations list specific deadlines for proposals.

For More Information

Contact the Program Manager, College and University Innovation Research, National Science Foundation, Washington, DC 20550, (202) 357-7527.

International Cooperative Scientific and Engineering Activities

(See "Quick Reference Chart," which summarizes information in this section.)

The Foundation encourages and supports U.S. participation in international science and engineering activities that promise significant benefit to the U.S. research and training effort.

It is Foundation policy to foster U.S. knowledge of science and engineering developments in foreign countries, to initiate and support international cooperative activities, to provide opportunities for scientific collaboration in developing countries, and to provide support to U.S. institutions for research done abroad.

Programs described in this section are designed to carry out the above policies. They are coordinated or managed by the Division of International Programs (INT) and complement other Foundation activities in support of scientific and engineering research.

INT welcomes inquiries about any of the programs listed and encourages U.S. scientists and engineers to discuss their plans with the staff of this division.

Deadlines

Some programs have deadlines for receipt of applications at NSF. Processing time for proposals for cooperative research, seminars, and long-term scientific visits averages six months, but seminar organizers often need to submit their proposals up to 12 months in advance for planning purposes.

Common Features

The programs are designed to support the work of U.S. scientists and engineers cooperating with those of other countries in mutually beneficial research, education, and related activities. The programs have the following general goals: to stimulate scientific progress by bringing U.S. scientists and engineers together with counterparts from other countries with complementary research capabilities; to provide U.S. science and engineering personnel with experience in working in other countries; to enhance scientific knowledge in priority areas of mutual interest; to assist U.S. scientists in obtaining access to important or unique research facilities and sites abroad; and to improve scientific ties with other nations and cultures, thus contributing to mutual understanding and the development of the scientific infrastructure here and abroad.

The NSF programs described below are not intended to affect other arrangements for binational scientific cooperation.

Except as described under each individual program, all have the following characteristics:

Types of Activities

Four types of activities may receive support: (1) cooperative research projects designed and conducted jointly by principal investigators from the United States and the foreign country; (2) long- and medium-term research visits for younger researchers to foreign centers of excellence; (3) research-oriented seminars or workshops (meetings of small groups of researchers from the United States and from the foreign country) to exchange information, review the current status of a specific field of science or engineering, and plan cooperative research; (4) short-term scientific visits for planning cooperative activities. The last category is not supported in some programs, particularly those with industrial countries; see below for details. (See also Chapter 8 for fellowships information.)

Eligibility

Eligible areas of research and related efforts are listed in the introduction to this publication. In several international programs, NSF and its counterpart agency in the foreign country have agreed on program priorities, which may include additional research areas.

In general, standard NSF eligibility criteria apply as to who may submit

DIVISION OF INTERNATIONAL PROGRAMS QUICK REFERENCE CHART

Country or Regional Programs	Phone (202)	Program Announcement	Coop. Research	Seminars Workshops	Planning Visits
Australia (4)	357-9564	--	D	D	A
China	357-7393	NSF 82-50	A	N	N
Eastern Europe Programs (1)	357-7494	NSF 80-46	A	A	N
U.S. India Exchange	357-9402	NSF 89-129			
India	357-9402	NSF 87-7	A	A	D
Japan (2)	357-9558	(See Notes)	D	D	N
Joint Fund Progs. (5)					
Hungary	357-7494				
Poland	357-7494				
Yugoslavia	357-9550				
Korea (ROK)	357-9537	NSF 83-50	A	A	A
Latin America Cooperative Programs (Argentina Brazil, Mexico, Venezuela)	357-9564	NSF 80-52	D	D	A
New Zealand (4)	357-9564	--	D	D	A
Science in Developing Countries (3)	--	NSF 83-58	A	A	A
Latin America	357-9564	--	-	-	-
Southeast Asia, Sub-Saharan Africa	357-9537	--	-	-	-
Taiwan (4)	357-7393	--	D	D	N
U.S.S.R. (4)	357-7494	NSF 89-100	D (6)	A	A
Western Europe Programs	357-7393	NSF 88-15	D	D	N
U.S. Israel BSF (5)	357-9402	--	D	N	N
All countries: Program for Long- and Medium-Term Research at Foreign Centers of Excellence (D)	357-7554	NSF 84-78	-	-	-

Notes: D = Please see text for proposal deadlines. A = Proposals may be submitted at any time. N = This category of support is not offered. (1) Currently includes Bulgaria, Czechoslovakia, Hungary, Poland, and Romania. (2) See text for different opportunities for collaboration with Japan. (3) See text for categories of support. (4) Contact NSF program office for announcement. (5) This is not an NSF program; announcement available on request (6) Consult appropriate disciplinary program for target dates or deadlines.

proposals for support under these programs. Except as indicated below, principal investigators/project directors should be U.S. scientists and engineers with professional experience equivalent to at least five years of postdoctoral scientific work. A U.S. scientist or engineer is a member of the U.S. scientific or engineering community who performs scientific or engineering work chiefly in the United States.

BILATERAL COOPERATIVE SCIENCE ACTIVITIES

Funding

In most programs, each country pays for the costs of the participation of its own scientists and engineers. Through the programs described below, NSF usually provides only the supplemental support required to introduce an international element to or broaden the international character of a research effort. Primary funding for an investigator's research may come from any U.S. funding source, including but not confined to the domestic research support programs at NSF.

Binational Approval

For cooperative research and seminars, the U.S. applicant sends a proposal to NSF; the cooperating scientist or engineer in the foreign country usually submits a corresponding proposal at the same time to the appropriate agency in that country. In formal bilateral programs, activities typically require approval of both NSF and its foreign counterpart agency before funding in either country.

For More Information

U.S. scientists and engineers may obtain further information about any international program, including program announcements (i.e., guidelines for the preparation of proposals), by writing to the particular program in care of the Division of International Programs, National Science Foundation, Washington, D.C. 20550.

Programs encourage, but do not require, preliminary inquiries from scientists and engineers who intend to apply for support.

The "Common Features" described above apply to the following programs except where noted below:

U.S.-Australia Cooperative Science Program

Types of Projects: cooperative research, seminars/workshops, and long- short-term visits.

Proposal deadline: April 1 for all projects to begin in the next calendar year.

U.S.-China Cooperative Science Program

Type of Project: cooperative research only.

Official counterpart organizations in China are the Chinese Academy of Sciences, the Chinese Academy of Social Sciences, the State Education Commission (formerly the Ministry of Education), and the Chinese National Natural Science Foundation. In general, all counterpart proposals on the Chinese side should be submitted through the established channels of these organizations, although other Chinese organizations may participate in the program.

Target dates for receipt of proposals: April 1 and November 1. Call for current program status (phone number on Quick Reference Chart).

U.S.-Eastern Europe Cooperative Science Programs

Includes bilateral programs with Bulgaria, Czechoslovakia, Hungary, Poland, and Romania. Please call the program office for current information.

Proposals may be submitted at any time of the year, but applicants are encouraged to submit their proposals by the target date of May 1.

U.S.-India Exchange of Scientists Program

Support of the program is provided from funds allocated by the U.S. Agency for International Development (AID). The agencies responsible for administering the exchange are the National Science Foundation in Washington, D.C., and the

Council of Scientific and Industrial Research in New Delhi.

The exchange program considers proposals from scientists for short-term visits to exchange information, identify possible areas for future collaboration, consult on on-going projects or programs, and scientific lectures.

Eligible for consideration are scientists and engineers affiliated with academic institutions, and governmental and industrial laboratories. Proposals may be from individuals with primary specialization in the mathematical, physical, biological, and information sciences, engineering, and the history and philosophy of science, as well as interdisciplinary areas.

Deadlines for U.S. applications: March 1 for visits after November 1; September 1 for visits after May 1.

Deadlines for Indian applications: November 30 for visits after May 1.

U.S.-India Cooperative Science Program

Types of projects: cooperative research, guest scientists, group travel to international conferences and workshops, and individual travel to conclude formal cooperative research proposals or to engage in research. Proposals for collaborative research must include an endorsement by the Indian Department of Science and Technology. Conference proposals should be submitted at least 12 months before the scheduled meeting.

This program primarily uses foreign currencies that are made available to the Foundation through special arrangements. U.S. applicants also may apply for supplemental dollar support where necessary to enhance the benefits of U.S. participation. Indian organizations may receive grants directly from NSF; they apply through their government.

Deadlines for proposals for travel to conclude formal cooperative research proposals or to engage in research: September 1 for travel between March 1 and August 31; March 1 for travel between September 1 and February 28.

U.S.-Republic of Korea Cooperative Science Program

Cooperative research, short- and long-term visits, and joint seminars are supported.

Proposals are accepted anytime.

U.S.-Latin America Cooperative Science Programs

Sponsors cooperative research, workshops, and short- and long-term visits between the United States and Argentina, Brazil, Mexico, and Venezuela.

Deadlines for cooperative research, workshops, and long-term visits: May 1 and November 1.

Short-term visit proposals may be submitted at anytime. (For other countries in South and Central America and the Caribbean, refer to Science in Developing Countries Program.)

U.S.-New Zealand Cooperative Science Program

Types of Projects: cooperative research, long- short-term visits, and joint seminars. Proposal deadline: July 1 for projects to begin in the next calendar year.

U.S.-Taiwan Cooperative Science Program

Deadlines for proposals: January 15 for cooperative research, July 15 for seminars and cooperative research proposals.

U.S.-U.S.S.R. Cooperative Science Program

Cooperative research, joint seminars/workshops, and individual scientific visits are supported. Only proposals in selected areas and topics are eligible. Seminars/workshops and individual visits are considered solely for the purpose of developing concrete proposals for long-term cooperative research. Proposals for developmental activities (workshops and individual visits) may be submitted at any time of the year. Because proposals for joint research projects will be evaluated through the merit review process of the individual NSF discipline-oriented programs, investigators should consult the appropriate discipline-oriented program concerning applicable deadlines or target dates.

U.S.-Western Europe Cooperative Science Programs

Cooperative research, joint seminars/workshops, and (with the exception of the U.S.-France program) long-term research visits (4 to 12 months) are supported.

See the following table for countries included, deadlines, and requirement for counterpart proposals:

Country	Deadlines	Counterpart Proposal Required?
Austria	March 1, Sept. 15	YES
Finland	March 1, Sept. 15	NO
France	May 1	YES
Germany	March 1, Sept. 15	NO
Italy	No deadline	YES
Netherlands	March 1, Sept. 15	NO
Sweden	March 1, Sept. 15	NO
Switzerland	March1, Sept. 15	YES
United Kingdom	March 1, Sept. 15	NO
Others*	No deadline	NO

*Belgium, Denmark, Iceland, Ireland, Norway, Vatican

U.S.-Japan Programs

U.S.-Japan Cooperative Science Program

Deadline: May 15 for seminars to be held during the one-year period commencing on April 1 of the following year, and for cooperative research projects with desired starting dates during the same period.

Research Visits

a. NSF Support for Research Visits to Japan (NSF 88-51). Proposals are accepted anytime. Support for 6- to 24-month research stays.

b. Japan Society for the Promotion of Science Postdoctoral Awards for United States Researchers (NSF 88-98). Application deadline: November 1. Support for 12-month research stays at academic research facilities in Japan to begin during the 12-month period starting April 1 the following year.

c. Science and Technology Agency of Japan Postdoctoral Awards for United States Researchers (NSF 88-52). Application deadline: November 1. Support for 6- to 24-month research stays to begin during the 12-month period starting April 1 the following year at Japanese national laboratories, public corporations, and certain nonprofit research organizations.

Awards for Japanese-Language Study by Researchers in Science and Engineering (NSF 88-118)

Deadlines: October 15 and December 15 for courses starting six months or more after the deadline.

SCIENCE IN DEVELOPING COUNTRIES PROGRAM (SDC)

The programs described in the previous sections have as their main purpose the improvement and international exchange of scientific knowledge. The Science in Developing Countries (SDC) program makes small grants (normally not to exceed $20,000 for the life of the project) that serve this purpose but may also be directed toward improving the scientific capabilities of developing countries.

Scientists and engineers from cooperating institutions abroad obtain the advantage of collegial relationships with U.S. scientists and engineers in specific projects that address priority problems of mutual interest. Participating U.S. scientists and engineers increase their opportunities to engage in research and have access to unusual resources. Projects that are relevant to the developing country and contribute to its capacity to train and use scientists and engineers are especially sought.

Grants are made to U.S. institutions, but projects often involve activities at a foreign site. When appropriate, project budgets include partial payment of support costs of developing-country counterparts. Counterpart scientists and institutions participate in both planning and implementation of project activities. The degree of local enthusiasm and the allocation of staff and financial support are important considerations in making awards.

Types of Projects

The following categories of awards are made to U.S. institutions that sponsor SDC projects:

- Short-term visits from five days to four weeks overseas to develop proposals for cooperative activities to be considered for funding under the SDC program. The short-term visit proposal must show evidence of prior active communication with colleagues in the developing country, as well as demonstrate the necessity of travel support to complete the cooperative research proposal.

- Research participation grants to support (1) the participation of U.S. scientists or engineers in a research or appropriate science education project in an eligible developing country; (2) the participation by scientists or engineers from an eligible developing country in an appropriate U.S.-based project; or (3) a combination of these. This program provides only supplemental costs related to collaboration; primary research costs are not provided.

- Grants to support national, regional, and international seminars that are research oriented and focused on developing-country problems.

- Dissertation improvement grants for the incremental support of developing-country graduate students who are enrolled at U.S. universities and qualified to undertake a dissertation research project. Among the costs covered are those for field equipment and supplies, and for travel to and from research sites. No stipend, tuition, or fees are provided. Only projects related to a developing-country problem and approved by a U.S. research advisor are considered for support.

Eligibility

Under the SDC program, NSF will consider proposals from institutions such as U.S. universities or colleges; nonprofit, nonacademic research institutions; and private for-profit organizations. All prospective principal investigators must be professionally qualified through training and work experience and be employed by a U.S. institution. Each proposal must identify a developing-country counterpart scientist or engineer and a counterpart institution. Such institutions may be local, regional, national, or international in character. Projects may have multiple sites and may involve more than one foreign institution.

Developing countries not explicitly included in any of the other programs in this section may be included under SDC. Interested parties are encouraged to call or write to NSF's Division of International Programs for guidance.

Deadlines

Target dates for receipt of proposals are September 1 and March 1. However, proposals may be submitted at any time. Processing time averages six months.

PROGRAM FOR LONG- AND MEDIUM-TERM RESEARCH AT FOREIGN CENTERS OF EXCELLENCE

This program supports U.S. citizens who have earned a doctoral degree or its equivalent within six years before beginning the visit. The program sponsors research visits of 3 to 12 months duration at foreign centers of scientific and engineering excellence.

Deadline for proposals is November 1. Funds may be requested for training in the appropriate foreign language.

JOINT FUND PROGRAMS

Government to Government

For the programs described in this section, institutions and investigators should be aware that special guidelines and procedures may apply.

U.S.-Israel Binational Science Foundation (BSF)

An agreement signed by the two governments in 1972 established a program of cooperative scientific research and related activities to be conducted principally in Israel, to be financed with Israeli currency, and to involve scientists and institutions of the United States and Israel. Activities must be of mutual interest to both countries.

The BSF office is located in Jerusalem, Israel. NSF and other U.S. Government agencies distribute information about BSF programs to U.S. scientists and organizations. The interests and activities of all scientific agencies of the U.S. Government in BSF are coordinated through the U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs.

The areas of research supported by BSF are health sciences, natural sciences, energy, and social and behavioral sciences. NSF encourages U.S. scientists to submit to BSF joint proposals of high quality that complement or otherwise relate to research supported under NSF programs. Proposals should be sent directly to U.S.-Israel Binational Science Foundation, P.O. Box 7677, Jerusalem 91076, Israel.

Proposals judged by BSF to be meritorious are referred to the U.S. Government for comment before they are funded.

Deadline for receipt of proposals in Jerusalem is November 15 each year. Awards are made the following August.

Program announcements and application forms may be requested by U.S. scientists working in research fields of interest to the National Science Foundation. Requests may be addressed to the Division of International Programs, National Science Foundation, Washington, D.C. 20550.

U.S.-Hungarian Joint Fund
Maria Sklodowska-Curie Joint Fund II (U.S.-Polish)
U.S.-Yugoslav Joint Fund

Based upon government-to-government agreements, Joint Boards administer cooperation in science and technology between researchers of partner countries. The National Science Foundation is one of several U.S. Government agencies that participate in the programs. NSF reviews research proposals in all fields of science and engineering normally supported by the Foundation, makes funding recommendations to the Boards and monitors approved activities. The Department of State exercises overall policy management on the U.S. side and provides the annual U.S. contribution to each Joint Fund, which serves as the source of financial support for all program activities.

Cooperative research proposals are jointly prepared by U.S. and foreign co-investigators and submitted to the Board by the foreign partner. Most financial support awarded under these programs goes to the foreign institution. No dollar support for research in the United States is available, but the Funds do support international transportation and subsistence expenses for U.S. investigators.

U.S. scientists working in fields of interest to the National Science Foundation who wish to participate in the Joint Fund programs are encouraged to contact the Division of International Programs, National Science Foundation, Washington, D.C. 20550, for program guidelines and procedures.

STATE-OF-THE-ART REVIEWS

This activity supports critical reviews by experts in specific disciplines, or by an interdisciplinary group, through International Information and Analysis Grants. Proposals will be accepted to collect and analyze information on the state-of-the-art of foreign research activities, including new developments in priority topics, and scientific trends and research opportunities in those fields of science and engineering that appear most promising for U.S. scientific involvement. Industry-university collaboration is encouraged in the selection and study of fields and countries. This program will support work to be done abroad, by U.S scientists and engineers, and may be in the form of a new grant or a supplement to an existing NSF grant. The overseas visit portion of a study may involve up to three persons. Proposals should include a plan for effective dissemination of the results of the work to the appropriate research community or communities in the United States.

Please direct comments, questions, or information to: Division of International Programs, National Science Foundation, 1800 G Street, NW, Washington, D.C. 20550. (202)-357-9632.

Science Resources Studies

Activities of the Division of Science Resources Studies fulfill the legislative mandate of the National Science Foundation Act to "...provide a central clearinghouse for the collection, interpretation, and analysis of data on the availability of, and the current and projected need for, scientific and technical resources in the United States, and to provide a source of information for policy formulation by other agencies of the Federal Government...." To carry out this mandate, the division performs:

- Periodic reviews of past and current national R&D funding and the supply and use of scientific and technical personnel; short- and long-term projections about those resources.
- Identification and analysis of factors responsible for changes in the science and technology resource system, and assessment of their effects.
- Collection, analysis, and dissemination of information on the economic, social, professional, and demographic characteristics of scientific and technical personnel.
- Compilation of information on U.S. and international science and technology resources and their characteristics and dynamics, and development of means to measure science and technology output.

Most of the work of this division is performed internally or through contractual agreements with other federal agencies and appropriate non-federal organizations. Extramural analyses of the division's extensive database and other special studies are occasionally supported through external awards. The topic areas in which awards are made include:

- Studies designed to give the factual information needed to track the training and distribution of the Nation's scientists and engineers. Specific areas of interest are the capability of the Nation's institutions of higher education to produce scientific and technical personnel, the current and future use of such personnel, and the changing characteristics of scientists and engineers.
- Collection, analysis, and dissemination of information on the characteristics and patterns of funding for research and development and for other scientific and technological activities. Support is also given to develop modeling and simulation techniques that will improve the capability to project R&D funding.
- Studies on the dynamics of the science and technology resource complex. A major component is the development of special indicators, primarily of an output nature. Also included are modeling and simulation activities. These are aimed at a better understanding of what causes changes in the distribution of human and financial resources for science and technology.
- Collection and analysis of data in the area of international S&T investments, activities, and capabilities. More extensive and more current information is sought on foreign science and technology inputs, outputs, and impacts. Cross-country comparisons of advances in specific fields or industries are also of interest. Emphasis is on the collection and analysis of data on the large R&D-performing countries.

Eligibility

Unsolicited proposals are welcome and are considered for awards. Profit making and other organizations are eligible to participate in the division's programs on the same basis as academic and nonprofit organizations.

Deadlines

In general, proposals may be submitted at any time during the year. Program announcements and requests for proposals are issued from time to time for special projects and studies in targeted areas; such solicitations specify deadlines for submission.

For More Information

Contact the Division of Science Resources Studies, National Science Foundation, Washington, D.C. 20550. (202) 634-4634.

Table 7—Scientific, Technological, and International Affairs

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Science Resources Studies	$ 5.31	$ 5.99
Policy Research and Analysis	0.84	0.85
Industrial S & T Innovation	20.05	22.93
Internat'l. Coop. Sci. Act.	11.24	12.08
Experimental Program to Stimulate Competitive Research	9.80	9.80
Total	$47.24	$ 51.65

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).

This table reflects the June 1990 reorganization of the former Directorate for Science and Engineering Education.

8

MAJOR INITIATIVES AND OTHER ACTIVITIES

Academic Research Facilities Modernization

This program is a competitive grant program with two primary goals: (1) to promote the modernization of graduate and undergraduate academic science and engineering research laboratories and related facilities at eligible institutions; and (2) to broaden and strengthen the nation's science and engineering base by assisting those academic institutions that historically have received relatively few federal research and development funds to improve their academic science and engineering infrastructures.

Nature of Support

The program is carried out through grant awards for the repair, renovation, or, in exceptional cases, replacement of facilities used for research and research training. The program's focus is on the physical plant, related infrastructure, systems and fixed equipment of general academic research laboratories and facilities used in fields of science supported by NSF. The program does not support instrumentation or equipment or major, highly specialized research facilities.

Eligibility

Eligible organizations are institutions of higher education, independent nonprofit research institutions, research museums, and consortia thereof. Organizations are expected to cost share (from non-federal sources) a minimum of 50 percent of the total project costs.

Proposal Submission and Awards

Proposals are submitted in response to a specific NSF program solicitation which contains all necessary information including actual due dates. Proposal submission and review is conducted in two phases, with organizations submitting an abbreviated Phase I proposal without detailed specifications or construction plans. After a review of these proposals, organizations that submitted the most competitive proposals are invited to submit more detailed Phase II proposals. Institutions compete within one of three separate groups for a targeted percentage of program funds. The most competitive Phase II proposals are selected for award.

Awards resulting from the first program solicitation, using FY 90 and FY 91 funds, will be made in the fall of 1990. It is anticipated that a program solicitation will be issued early in 1991 for awards which would be made in FY 92.

For More Information

Contact the Research Facilities Office, National Science Foundation, Washington, D.C. 20550. (202) 357-9785.

At Jackson State University, NSF supports student research through its Research Careers for Minority Scholars program.

Science and Technology Research Centers

The goal of this program is to help maintain U.S. preeminence in science and technology by funding research activities that call for cooperation among a group of scientists, engineers, and their students. Science and Technology Centers (STCs) exploit opportunities in science and technology where the complexity of the research problems requires the advantages of scale, duration, facilities, or collaborative relationships that can best be provided by campus-based research centers. The STC competition is one of the vehicles used by NSF to fund comprehensive programs where specific problems need center-like funding to ensure world-class quality and competitiveness. Examples of center-like activities which the Foundation has supported but is not limited to, include: global change, computational science and engineering, advanced materials, biodiversity, decision sciences, cognition, neural science, behavioral science, Arabidopsis, genome research, biotechnology, plant and reproductive biology.

In fiscal year 1989 the STC Program made its first awards for research centers. A second competition is underway, and awards will be made in fiscal year 1991. STC topics are not chosen by the Foundation in advance. Rather, the successful STCs emerge from a highly competitive and technical-based merit review process and may include areas broadly recognized as important as well as fields newly emerging and significant.

For more information, contact the Office of Science and Technology Centers Development, National Science Foundation, Washington, D.C. 20550 (202) 357-9808.

Career Development Initiative

A new component, Women in Engineering, has been added to the Graduate Research Fellowship programs described in chapter 3. A total of 80 additional fellowships for Women in Engineering will be offered beyond the 920 fellowships offered for all fields of science and engineering.

Undergraduate Initiative

In addition to programs and activities described in previous chapters, NSF has expanded support for undergraduate science and engineering. This initiative is Foundation-wide, with activities funded by the research directorates and by the Directorate for Education and Human Resources (EHR) as well. EHR also plays a coordinating role through its Division of Undergraduate Science, Engineering, and Mathematics Education and its Human Resources Development Unit.

Under the new initiative, programs have been developed in these major areas, summarized below: students, laboratories, faculty, curriculum development, and career access.

Students

- **Research Experiences for Undergraduates (REU)**—This program provides opportunities for undergraduate students to experience hands-on participation in research or related scholarly activity in the sciences, mathematics, and engineering. The Foundation provides support to researchers to involve students in meaningful ways in either ongoing research or in programs designed especially for this purpose. REU is supported by all of the Foundation's disciplinary research programs.

Special opportunities for minority undergraduates are described under the initiative for underrepresented populations.

Laboratories

- **Instrumentation and Laboratory Improvement**—Through matching grants for the purchase of undergraduate instructional apparatus, this program supports instrumentation-based projects to generate more effective and efficient approaches to laboratory- and field-based instruction. Assisted by substantial cost sharing by the awardee institutions, states, equipment manufacturers, and other elements of the private sector, the program stimulates important laboratory instructional improvements in the nation's colleges and universities. This program is supported by the Directorate for Education and Human Resources.

Faculty

Three activities provide special education and research opportunities for undergraduate faculty (see chapter 3 for descriptions):

- **The Undergraduate Faculty Enhancement Program (UFE)**—for conferences and seminars.
- **Research in Undergraduate Institutions (RUI)**—for research grants to faculty in nondoctoral departments of predominantly undergraduate institutions.
- **Research Opportunity Awards (ROA)**—which provide a means for faculty in predominantly undergraduate institutions and minority science teachers to participate in research in association with NSF-funded researchers at other institutions.

Curriculum Development

- **Undergraduate Curriculum and Course Development in Engineering, Mathematics and the Sciences**—This program is part of the National Science Foundation's evolving long-range plan to add programs to (1) support better undergraduate lecture and laboratory instruction, including large-enrollment introductory course laboratories, (2) develop a better understanding of U.S. undergraduate science, engineering, and mathematics education, and of teaching and learning processes, (3) improve ways science, engineering, and mathematics are taught at the introductory level to help assure the scientific and technological literacy of all students, and (4) support a broad-based program to develop undergraduate courses and curricula.

For More Information

Inquiries may be made to NSF's Division of Undergraduate Science, Engineering, and Mathematics Education, Washington, D.C. 20550, (202) 357-9644 or to the appropriate research directorate. For information about the RUI and ROA programs, contact Human Resources Development Division, National Science Foundation, Washington, D.C. 20550, (202) 357-5052.

Underrepresented Populations Initiative

Numerous studies and reports have documented that the U.S. is not attracting sufficient numbers of its students into science and engineering careers, and that women, minorities, and persons with disabilities are presently underrepresented in all disciplines. Therefore, NSF has instituted a number of activities directed specifically at attracting and retaining these students to science and engineering, as well as at increasing the number of women, minorities, and persons with disabilities who are full participants in the mainstream of the nation's research activities. While some programs are centrally managed, many are distributed throughout the disciplinary directorates and managed by the cognizant program officers. Most of these efforts are described in chapter 3, but some divisions and directorates have special efforts which are described in their respective chapters.

This initiative is composed of multiple efforts:

- to attract women to science and engineering careers and to enhance their participation in active research programs;
- to significantly improve the quality of instruction and experiences available in science and engineering to minority students at all educational levels;
- to increase the numbers of students attaining degrees in science and engineering and pursuing science and engineering careers;
- to strengthen the science and engineering capability of institutions with significant minority enrollments; and
- to build effective coalitions and alliances that employ the strengths of many institutions and organizations to accomplish these objectives.

Other Activities

DOCTORAL DISSERTATION RESEARCH IMPROVEMENT

The Foundation awards grants to improve the scientific quality of doctoral dissertation research. Awards are made to allow doctoral candidates opportunities for greater creativity in the gathering and analysis of data than would otherwise be possible. Grants are intended to cover research-related expenses. These include expenses for field equipment and supplies and for travel to and from research sites. These awards are not fellowships, and no stipend is included. Support is not provided for everyday personal expenses of the doctoral student. However, the student may concurrently receive such support from other sources.

Dissertation proposals are judged on the basis of scientific content, importance, and originality. In addition, the doctoral candidate must show that the award will in fact improve the quality of the research.

Dissertation improvement awards are available only in certain disciplines. These include the social and behavioral sciences and certain biological sciences. No dissertation improvement awards are made in the mathematical and physical sciences, geosciences, engineering, cellular and molecular biology, or physiology.

Eligibility/For More Information

Each division that administers these grants treats applications in a different way. Doctoral students who wish to apply for a dissertation improvement grant should write directly to the appropriate research division(s).

INFORMATION FOR SMALL BUSINESSES

NSF programs are of interest mainly to those small business concerns with strong capabilities in scientific or engineering research or in science-based innovative technology. Competition for awards from NSF is intense, and only high-quality research proposals are supported.

Most NSF funds are obligated through grants to support unsolicited research proposals judged scientifically meritorious in merit review. Note that these are grants, not procurements. Small firms may submit proposals under most of the programs identified in this *Guide*.

Although NSF programs mainly fund research in academic institutions, proposals from the commercial sector, including small research firms, are also supported.

Most NSF research awards to small businesses are those grants made through the Small Business Innovation Research (SBIR) program, described elsewhere in this chapter. SBIR is conducted pursuant to the Small Business Innovation Development Act of 1982, P.L. 97-219. Grant proposals under this program are solicited by a formal SBIR program solicitation issued annually.

When compared with other federal departments and agencies, procurement or contract opportunities at NSF are quite limited. The Foundation generally does not maintain bidders lists; competitive procurement opportunities are normally publicized in the Commerce Business Daily. Opportunities for small companies exist in the subcontracting activities of the NSF prime contractors which manage other major research facilities. Some of these facilities are identified elsewhere in this *Guide*.

NSF has two offices which provide information and serve as referral points for small businesses that are interested in the Foundation's research or procurement opportunities. Note that these offices do not administer any individual grant, contract, or procurement programs.

The Office of Small Business Research and Development offers information and guidance on NSF programs and research opportunities to research- and technology-based small firms.

The Office of Small and Disadvantaged Business Utilization also provides information and guidance to small, minority, and women-owned companies seeking procurement opportunities to provide NSF or its major prime contractors with goods or services.

The address for both these offices is Room 1250, National Science Foundation, Washington, D.C. 20550. (202) 357-7464.

NSF POSTDOCTORAL FELLOWSHIPS

NSF sponsors 13 fellowship programs for postdoctoral and senior postdoctoral research in science and engineering. These fellowships are in specific disciplines and are sponsored by the appropriate NSF organization. Contact the appropriate division listed below for more information about these fellowships.

SMALL GRANTS FOR EXPLORATORY RESEARCH (SGER)

The Foundation funds small-scale exploratory work in all fields of science, engineering, and education supported by NSF, through brief proposals without the usual external review. Such work includes preliminary research on untested and novel ideas; ventures into emerging research areas; research requiring urgent access to specialized data, facilities, or equipment; or similar exploratory efforts likely to catalyze innovative advances.

Programs may use up to five per cent of their budgets for SGER awards. SGER proposals are normally for one year and may not exceed $50,000, with the average amount depending on the particular program; they are non-renewable. Only one copy of a brief proposal is required. NSF program officers are not required to seek advice from external reviewers before making their recommendations; thus, PIs are strongly encouraged to contact the appropriate program officer to see if the proposed research would be suitable for SGER support or should be submitted as a fully reviewable proposal.

For More Information

Order brochure NSF 89-85 from National Science Foundation, Forms and Publications, Room 232, Washington, D.C., 20550. (202) 357-7861.

Fellowship	Contact
BBS Minority Postdoctoral Research Fellowship Program	BBS Minority Postdoctoral Research Fellowship Program Room 321 National Science Foundation Washington, D.C. 20550 Tel: (202) 357-7474
Fellowship Opportunities in Environmental Biology for Ph.D.s	Postdoctoral (EB) Fellowships Room 215 Division of Biotic Systems and Resources National Science Foundation Washington, D.C. 20550 Tel: (202) 357-7332
Postdoctoral Research Fellowships in Plant Biology	Division of Molecular Biology (DMB) or Division of Cellular Biology (DCB) National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9400 (DMB) Tel: (202) 357-7905 (DCB)
Postdoctoral and Senior Postdoctoral Research Fellowships in History and Philosophy of Science	NSF Postdoctoral Research Fellowships in History and Philosophy of Science Division of Instrumentation and Resources Room 320 National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9894
Earth Sciences Postdoctoral Research Fellowship	Division of Earth Sciences Room 602 National Science Foundation Washington, D.C. 20550 Tel: (202) 357-7958
Research Fellowships in Marine Biotechnology in the Ocean Sciences	Division of Ocean Sciences Room 609 National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9498
Fellowships for Japanese-Language Study by Researchers in Science and Engineering	Japanese Language Fellowships Room 1208 Division of International Programs National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9558 Electronic Mail: cwallace@nsf.gov

Fellowship	Contract
Japan Society for the Promotion of Science (JSPS) Postdoctoral Awards for U.S. Researchers	JSPS Postdoctoral Awards Room 1208 Division of International Programs National Science Foundation Washington, D.C. 20550 Tel: [illegible]58 Electronic Mail: cwa[illegible]ow
Mid-Career Science and Technology Agency of Japan Postdoctoral Awards for U.S. Researchers	STA Postdoctoral Awards Room 1208 Division of International Programs National Science Foundation Washington, D.C. 20550
Mathematical Sciences Postdoctoral Research Fellowships (with Research Instructorship Option)	Special Projects Program Room 339 Division of Mathematical Sciences National Science Foundation Washington, D.C. 20550 Tel: (202) 357-3453
Postdoctoral Research Fellowships in Chemistry	Postdoctoral Research Fellowships in Chemistry Division of Chemistry National Science Foundation Washington, D.C. 20550 Tel: (202) 357-7956
NSF-NATO Postdoctoral Fellowships in Science and Engineering	NATO Postdoctoral Fellowship Program Division of Research Career Development National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9466
Long- and Medium-Term Research Visits for Scientists and Engineers at Foreign Centers of Excellence	Long- and Medium-Term Research Visits Division of International Programs National Science Foundation Washington, D.C. 20550 Tel: (202) 357-9700

Table 8—Research Facilities Modernization

(Dollars in Millions)

	FY 1990 Current Plan	FY 1991 Request
Research Facilities Modernization	$19.69	$20.00

SOURCE: Fiscal Year 1991 Budget to Congress—Justification of Estimates of Appropriations (Quantitative Program Data Tables).

Appendix I

Major Centers, Groups, And National Facilities Supported By NSF

Astronomy centers (Arecibo, Cerro Tololo, Kitt Peak, etc.)	See chapter 6 (MPS)
Atmospheric sciences (National Center for Atmospheric Research, Upper Atmospheric Facilities)	See chapter 5 (GEO)
Biological facilities/research centers	See chapter 1 (BBS)
Engineering Research Centers (ERCs)	See chapter 4 (ENG)
Industry-University Cooperative Research Centers (IUCRs)	See chapter 4 (ENG)
Long-Term Ecological Research (LTER) sites	See chapter 1 (BBS)
Materials research groups/labs/national facilities	See chapter 6 (MPS)
Minority Research Centers of Excellence (MCRE)	See chapter 7 (STIA)
National Center for Earthquake Engineering Research	See chapter 4 (ENG)
National facility for advanced neutron research	See chapter 6 (MPS)
National Center for Geographical Information Systems	See chapter 1 (BBS)
Oceanographic centers and facilities	See chapter 5 (GEO)
Plant science centers	See chapter 1 (BBS)
Science and Technology Centers (STCs)	See chapter 8 (other)
Supercomputer centers	See chapter 2 (CISE)

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Appendix II

NSF Cross Directorate Activities and Targeted Programs FY 1991

Program	Announ. Number	Managed by	Deadline	Coordinator or Contact	Phone (202) 357-
FACULTY (RESEARCH)—PREDOMINANTLY UNDERGRADUATE INSTITUTIONS:[1]					
Regular Prog. Support	Prog.	Prog.	Prog.	Prog.Officer	
Research in Undergraduate Instit.	89-60	Prog.	Prog.	L.Rogers/ EHR	7456
Research Opportunity Awards	(copy)	Prog.	None	L.Rogers/ EHR	7456
UNDERGRADUATE FACULTY—ALL INSTITUTIONS:					
Undergraduate Faculty Enhancement	89-88	Prog. + EHR/USEME	4/16/91	W.Haver EHR/USEME	7051
UNDERGRADUATE STUDENTS—ALL INSTITUTIONS:					
Research Experiences for Undergraduates	90-79			EHR/USEME	7051
—Sites		Dir./Div.	10/10/90	see 90-79	
—Supplements		Prog.	None	Prog.Officer	
Instrumentation & Laboratory Improvement	89-79	EHR/USEME	11/13/90 EHR/USEME	D.McBride	7051
Undergraduate Curriculum Development: Mathematics/Calculus	89-82	EHR/USEME		J. Bradley EHR/USEME	7051
—Conf.& Wkshops			None		
—Curric.Develop.			2/2/91		
Undergraduate Curriculum & Course Development	89-125	EHR/USEME	10/15/90	EHR/USEME	7051
WOMEN:					
Research Initiation Consid.	Prog.	Prog.	Prog.	Prog.Officer	
Research Planning Grants		Prog.	12/1	EHR/HRD Prog.Officer L.Rogers	7456

Career Advancement Awards		Prog.	12/1	EHR/HRD Prog.Officer L.Rogers	7456
Visiting Professorships for Women	89-37	EHR/HRD	11/15	M.Klein EHR/HRD	7734
Faculty Awards for Women	90-27	DIR/DIV	9/1	S.Ortega EHR/HRD	5052
MINORITIES:					
Research Assist. for Minority High School Students	89-39	Prog.	None	L.Rogers EHR/HRD	7456
Research Improvement in Minority Institutions	89-7	EHR/HRD	12/1 & 3/1	R.Johnson EHR/HRD	7350
Minority Research Initiation	—			R. Calbert EHR/HRD	7350
—Research Planning		Prog. + EHR/HRD	2/2 & 6/2		
—Research Initiation		Prog.	Prog.	Prog.Officer	
—Career Advance.		Prog.	Prog.	Prog.Officer	
Minority Research Centers of Excellence	—	EHR/HRD	None	R.Calbert EHR/HRD	7350
Research Careers for Minority Scholars	88-126	EHR/HRD	None	A.Bridgewater EHR	7350
BBS Minority Post-Doc.Res. Fellowships	90-53	BBS/DIR	11/1/90	T.Quarles BBS/DIR	9880
Alliances for Minority Partic.	90-44	EHR/HRD	1/31/91	A.Bridgewater EHR	7350
PERSONS WITH DISABILITIES:					
Facilitation Awards for Handicapped Scientists & Engineers	84-62 Rev.5/87	Prog.	None	L.Rogers EHR/HRD	7456
WOMEN, MINORITIES, AND DISABLED:					
Career Access Oppor. In S&T for Women, Minorities, & the Disabled —Comp.Reg.Centers for Minorities —Prototype & Model Projects for Women, Minorities, & Disabled	89-126	EHR/USEME	4/2/91	T.Reid EHR/USEME	7051

Grad.Engin.Ed.for Women,Minorities & Persons with Disabilities	90-38	ENG/EID	6/1/90	L.Morse ENG/EID	786-9631

STATES UNDERREPRESENTED IN RESEARCH:

Experimental Prog. to Stimulate Competitive Research	90-32	STIA + Prog.	1/15/91	J.Danek R.Anderson B.Reiss STIA	7560

FACULTY (RESIDENT/VISITING), STUDENTS, POSTDOCS, INDUSTRIAL FELLOWS:

S&T Centers	89-17	Prog.+ OSTC	(Sum.'91)	W.Harris OD/STC	9808

YOUNG FACULTY INVESTIGATORS:

Presidential Young Investigators	90-68	Prog.	10/1/91	E.Ferrand EHR/RCD	9466

SMALL BUSINESS:

Small Business Innovation Research:	90-31			R.Coryell R.Tibbets D.Gorman	7527 7527 9804
—Phase I		Prog.	(6/91)	STIA/IST	
—Phase II		Prog.	30 days/ End Ph.1		

ETHICS/VALUES RESEARCHERS:

Ethics and Values Studies	89-8	BBS/DIR	5/1&11/1 8/1&2/1	R.Hollander BBS/DIR	9894

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[1] Eligible institutions grant baccalaureate degrees in NSF-supported fields, or provide programs of instruction for students pursuing such degrees with institutional transfers; have undergraduate enrollment exceeding graduate enrollment; award no more than 20 Ph.D.s for D.Sci. in all NSF-supportable disciplines during the two academic years preceding proposal submission.

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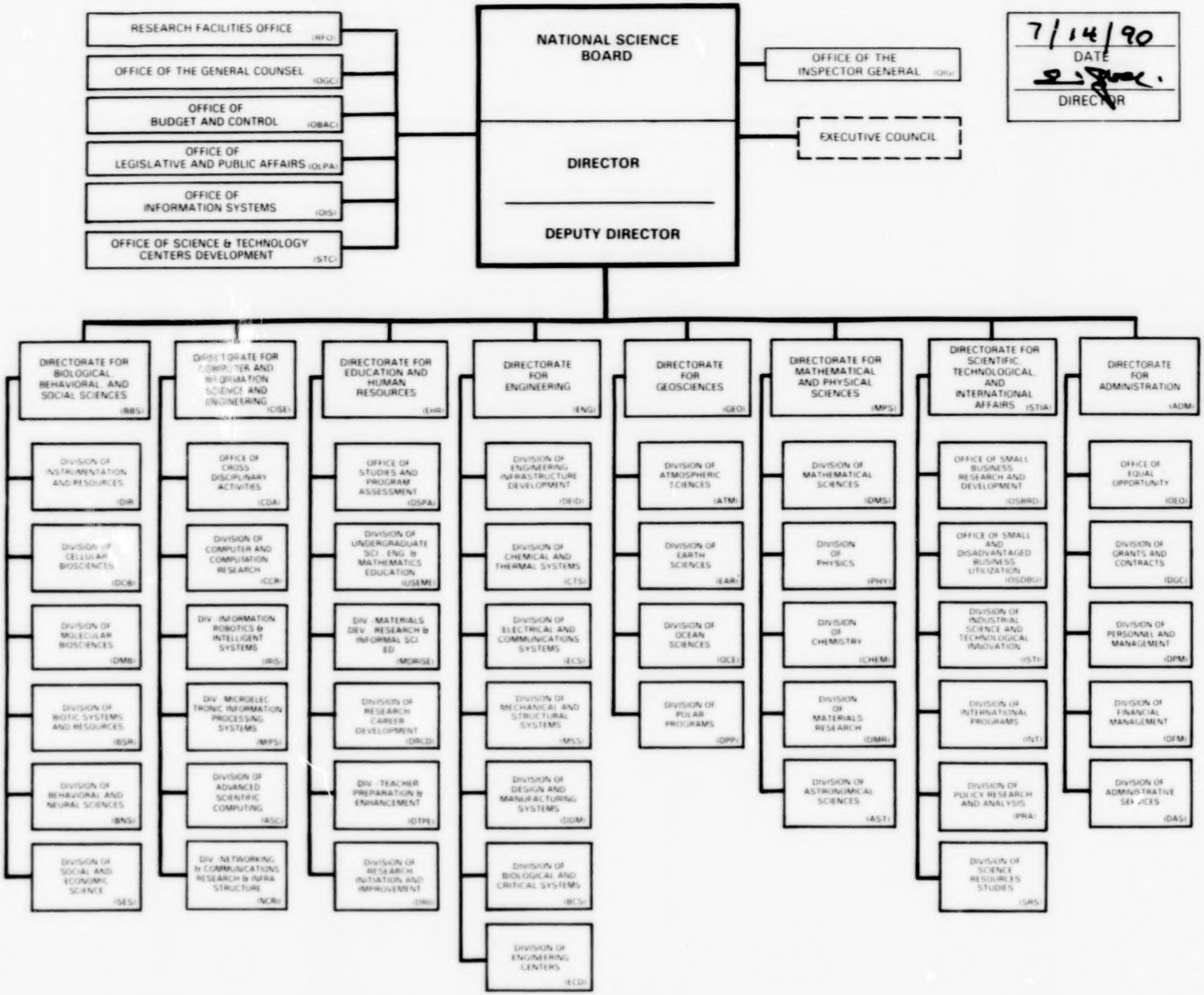
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DIVISION OF CELLULAR BIOSCIENCES (DCB)
DIVISION OF MOLECULAR BIOSCIENCES (DMB)
DIVISION OF BIOTIC SYSTEMS AND RESOURCES (BSR)
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DIVISION OF SOCIAL AND ECONOMIC SCIENCE (SES)
DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING (CISE)
OFFICE OF CROSS DISCIPLINARY ACTIVITIES (CDA)
DIVISION OF COMPUTER AND COMPUTATION RESEARCH (CCR)
DIV. INFORMATION ROBOTICS & INTELLIGENT SYSTEMS (IRIS)
DIV. MICROELECTRONIC INFORMATION PROCESSING SYSTEMS (MIPS)
DIVISION OF ADVANCED SCIENTIFIC COMPUTING (ASC)
DIV. NETWORKING & COMMUNICATIONS RESEARCH & INFRASTRUCTURE (NCRI)
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DIVISION OF RESEARCH INITIATION AND IMPROVEMENT (DRII)
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OFFICE OF SMALL BUSINESS RESEARCH AND DEVELOPMENT (OSBRD)
OFFICE OF SMALL AND DISADVANTAGED BUSINESS UTILIZATION (OSDBU)
DIVISION OF INDUSTRIAL SCIENCE AND TECHNOLOGICAL INNOVATION (ISTI)
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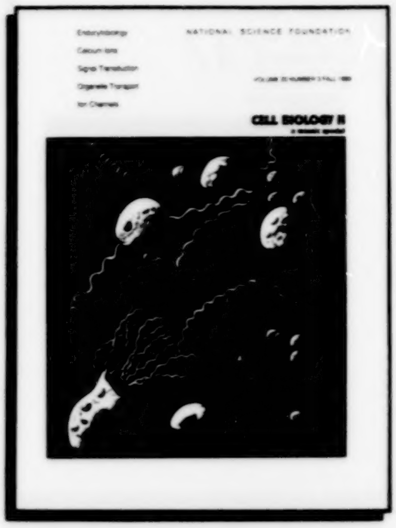

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The NSF Outreach Service will respond to written requests for NSF speakers by attempting to arrange, when possible, for traveling staff to visit the requesting institution. Requests should be made through a research or similar administrative office of the requesting institution to avoid duplication. Because of limited availability of staff time and travel funds, priority consideration is given to requests for presentations serving faculties from several institutions. These include NSF regional workshops with proposal development sessions.

Interested persons may contact Lola E. Rogers, Directorate for Education and Human Resources.

OTHER INFORMATION

The Foundation provides awards for research in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the results for publication. The Foundation, therefore, does not assume responsibility for such findings or their interpretation.

The Foundation welcomes proposals on behalf of all qualified scientists and engineers, and strongly encourages women, minorities, and persons with disabilities to compete fully in any of the research and research-related programs described in this document.

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Facilitation Awards for Handicapped Scientists and Engineers (FAH) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on an NSF project. See the FAH program announcement, or contact the FAH Coordinator in the Directorate for Scientific, Technological, and International Affairs.

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